

**REGIONAL FOOD SYSTEMS AND FOOD SECURITY:
EXPLORING DIETARY CHARACTERISTICS IN THE
NORTHEAST UNITED STATES**

**by
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ABSTRACT

Introduction

Current food systems may be vulnerable to global environmental changes that could increase food insecurity, including in the Northeast United States. Expanding regional food systems may be able to provide regional food security in light of environmental changes. The purpose of this research was to explore the dietary characteristics of the Northeast to better understand the food needs of the region and the potential of a regional food system to help meet those needs.

Methods

Using the Ecological Systems Theory, we explored dietary characteristics of the Northeast and their associations with sociodemographic factors within a regional food systems context. The region was characterized by reviewing several publicly available datasets. Food purchasing data from the Bureau of Labor Statistics Consumer Expenditure Diary Survey were used to measure purchasing in 12 food categories as indicators of dietary characteristics. Several multiple logistic regression models were used to analyze the relationship between sociodemographic factors and purchasing of food categories. Latent variable methods were used to analyze customer intercept survey data from the USDA-funded Enhancing Food Security in the Northeast project to assess relationships among dietary patterns and sociodemographic factors.

Results

The Northeast is unique in regard to several sociodemographic factors including age, sex, ethnicity, education, income and participation in federal food assistance programs. Land use and agriculture production findings showed the need and opportunities for developing a regional food system. Findings also demonstrated differences in dietary characteristics by several sociodemographic factors, including having children less than 18 years of age, the interaction between household income and education, ethnicity and race. Latent variable methods revealed four different dietary patterns among the sample of EFSNE participants. Latent class regression indicated that several sociodemographic factors were associated with the dietary patterns.

Conclusions

This research presented findings that improve our knowledge of the dietary characteristics of the Northeast. These characteristics and their associations with sociodemographic factors help to understand the underlying factors of diet at the regional level and the potential for a regional food system to meet dietary needs. These findings could serve as important foundations for additional research and food system activities that attempt to achieve regional food security.

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TABLE OF CONTENTS

Abstract.....	ii
Acknowledgements.....	v
Table of Contents.....	vii
List of Tables.....	ix
List of Figures.....	xii
CHAPTER 1 – INTRODUCTION AND SPECIFIC AIMS.....	1
Introduction.....	2
Background.....	3
Theoretical Foundations.....	16
Public Health Significance.....	19
Specific Aims.....	19
Dissertation Overview.....	20
References.....	21
CHAPTER 2 – RESEARCH METHODS.....	32
Aim 1	
Data Sources.....	33
Analysis.....	36
Aim 2	
Data Sources.....	38
Analysis.....	40
Aim 3	
Study Design.....	42
Sampling and Recruitment.....	42
Data Collection and Instruments.....	44
Selection of Market Basket Items.....	45
Analysis.....	49
References.....	52
CHAPTER 3 – MANUSCRIPT 1: RELEVANT CHARACTERISTICS OF REGIONAL FOOD SECURITY IN THE NORTHEAST.....	57
Abstract.....	58
Introduction.....	60
Methods.....	62
Results.....	66
Discussion.....	72
Conclusions.....	75
References.....	77
CHAPTER 4 – MANUSCRIPT 2: DIETARY CHARACTERISTICS IN THE NORTHEAST UNITED STATES: FOOD PURCHASES AND SOCIODEMOGRAPHIC CHARACTERISTICS.....	86
Abstract.....	87
Introduction.....	89
Methods.....	92
Results.....	95
Discussion.....	99

Conclusions.....	104
References.....	106
CHAPTER 5 – MANUSCRIPT 3: IDENTIFYING DIETARY PATTERNS WITH A REGIONALLY SIGNIFICANT MARKET BASKET IN THE NORTHEAST UNITED STATES	116
Abstract.....	117
Introduction.....	119
Methods.....	122
Results.....	131
Discussion.....	136
Conclusions.....	143
References.....	144
CHAPTER 6 – INTEGRATIVE SUMMARY.....	154
Summary of Findings.....	155
Integration of Findings.....	158
Implications and Recommendations.....	159
References.....	161
APPENDICES.....	163
Appendix A: Sociodemographic Characteristics by State	165
Appendix B: Categorization of USDA Food Categories and Diary Survey Items.....	174
Appendix C: EFSNE Consumer Intercept Survey.....	176
References.....	182
CURICULLUM VITAE.....	183

LIST OF TABLES

Table 2.1: Categorization of USDA Food Categories and Bureau of Labor Statistics

Diary Survey Items

Table 2.2: Households Participating in Bureau of Labor Statistics Diary Survey

Compared with Portion of Total Northeast Households

Table 2.3: Sampling Characteristics of Supermarkets Participating in EFSNE

Table 3.1: Comparison of Intrapersonal Level Characteristics between the United States

and the Northeast Region

Table 3.2: Comparison of Interpersonal Level Characteristics between the United States

and the Northeast Region

Table 3.3: Comparison of Community Level Characteristics in the Northeast United

States

Table 3.4: Comparison of Public Policy Level Characteristics in the Northeast United

States

Table 3.5: Total Production, Total Consumption and Regional Self-Reliance by USDA

Category

Table 4.1: Sample Characteristics of the Bureau of Labor Statistics Diary Survey 2012 –

2014 (N=3,428)

Table 4.2: Purchasing Characteristics of USDA Categories (N=3,428)

Table 4.3: Multivariate Analysis of Purchasing: Milk and Dairy, Meats and Poultry

(N=3,428)

Table 4.4: Multivariate Analysis of Purchasing: Seafood, Eggs and Cured Meats

(N=3,428)

Table 4.5: Multivariate Analysis of Purchasing: Non-Meat Proteins, Grains and Fruit

(N=3,428)

Table 4.6: Multivariate Analysis of Purchasing: Vegetables, Snacks and Mixed Dishes

(N=3,428)

Table 4.7: Associations Between Sociodemographic Factors and Food Purchasing for 12

USDA Categories

Table 5.1: Sociodemographic Characteristics of EFSNE Participants (N=1,996)

Table 5.2: Latent Class Analyses of EFSNE Market Basket Purchases: Model Fit

Statistics (N=1,996)

Table 5.3: Latent Class Analysis of EFSNE Market Basket Purchases: Latent Class and

Conditional Probabilities (N=1,841)

Table 5.4: Multivariate Latent Class Regression Analyses of EFSNE Market Basket

Purchases (N=1,841)

Table 6.1: Application of Ecological Systems Theory to Dietary Characteristics and

Regional Food Security

Appendix A.1: Population, Sex and Age of Residents in the Northeast United States by

State

Appendix A.2: Educational Attainment of Residents in the Northeast United States by

State

Appendix A.3: Income, Poverty Status and Unemployment of Residents in the Northeast

United States by State

Appendix A.4: Race and Ethnicity of Residents in the Northeast United States by States
by State

Appendix A.5: Composition of Households in the Northeast United States by State

Appendix A.6: Urbanicity and Population Density in the Northeast United States by
States

Appendix A.7: Retail Food Environment of the Northeast United States by States

Appendix A.8: Federal Food Program Participation in the Northeast United States by
State

Appendix B.1: Categorization of USDA Food Categories and Diary Survey Items

Appendix C.1: EFSNE Recruitment: Sampling Characteristics of Supermarkets
Participating in EFSNE

LIST OF FIGURES

Figure 1.1: Household Food Insecurity in the Northeast United States

Figure 1.2: Food System Components

Figure 1.3: Application of Ecological Systems Theory to Regional Food Security

Figure 3.1: Use of Agricultural Land Contributing to the Food Supply in the Northeast

Figure 5.1: Purchasing of EFSNE Market Basket Items: Number and Types (N=1,996)

Figure 5.2: Conditional Probabilities for a Latent Class Analysis of EFSNE Regional
Market Basket (N=1,841)

Appendix C.1: EFSNE Customer Intercept Survey

CHAPTER 1
INTRODUCTION AND SPECIFIC AIMS

INTRODUCTION

Food insecurity is associated with a higher risk of diet-related diseases in individuals and is a significant risk factor of morbidity and mortality (Seligman, Laraia, & Kushel, 2010). The health impacts of food insecurity have led to an increase in research into its many causes over recent years. The literature suggests that despite significant advancements in food production, processing and distribution obtaining adequate food remains a problem for many Americans and is a growing problem in the Northeast United States (Coleman-Jensen, Gregory, & Singh, 2014). Experts believe that global environmental changes may have damaging effects on the U.S. food system, which could increase food insecurity in the region (Lake et al., 2012; Murray, 2013; Tacoli, Bukhari, & Fisher, 2013).

Food systems research can provide insights into improving food security. Food system research is the examination of the infrastructure, processes and outcomes involved with feeding a population (Ericksen, 2008a). One emerging area of research is the potential for more robust regional food systems, which emphasize the production, distribution and consumption of foods specific to a defined geographic area (Clancy & Ruhf, 2010). To date, most of this research has centered on production and distribution, leaving significant gaps in understanding demand-side factors like dietary characteristics. The purpose of this research is to improve the understanding these characteristics in the Northeast region, which could advance our understanding of the capability for regional food systems to improve food security. The following research aims were used to guide this research:

Aim 1: Describe characteristics relevant to regional food security in the Northeast.

Aim 2: Explore dietary characteristics in the Northeast region and their associations with sociodemographic factors.

Aim 3: Identify specific dietary patterns using a regionally significant market basket and their associations with sociodemographic factors.

BACKGROUND

Defining Food Security

Broadly, food security is the state or condition of having adequate food. Specific definitions of food security have evolved over time. For instance, in 1974 when shortages in the global food supply were determined to be the cause of inadequate food the United Nations (U.N.) defined food security as, “availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices” (Clay, 2002, p. 2). While the U.N. definition is still used in some applications, recent definitions reflect greater recognition of limitations in accessing food. For example, the current definition of household food security used by the United States Department of Agriculture (USDA) is, “access by all

people at all times to enough food for an active, healthy life” (Coleman-Jensen et al., 2014, p. 2).

For the purpose of this dissertation, we will focus on regional food security. Regional food security exists when a region achieves community food security by producing as much food as possible within the region without degrading its resources base. Regional food security has foundations in two related concepts. The first is community food security. Defined by Hamm and Bellows, community food security is “a condition in which all community residents obtain a safe, culturally acceptable, nutritionally adequate diet through a sustainable food system that maximizes community self-reliance and social justice” (2003, p.1). This definition is unique in that it emphasizes the food needs of communities (in this case, the region); stresses the ability of communities to meet their food needs; and focuses on the sustainable and equitable use of resources (Anderson & Cook, 1999; Gottlieb & Fisher, 1996; Hamm & Bellows, 2003; Joseph, Winne, & Fisher, 1997; United States Department of Agriculture, 2015a).

The second concept is self-reliance, which is derived from Food and Agriculture Organization of the United Nations concept of self-sufficiency, and is defined as the extent to which a country or region is able to satisfy its food needs through domestic production (Clapp, 2015). As Clapp (2015, p. 6) states, greater self-sufficiency provides, “a contingency against supply disruptions that may arise in the context of war, a decline in availability of food on international markets, or volatile food prices on international markets”.

Regional food security is well suited for a systems approach, which according to Leischow and Milstein (2006, p. 403) is, “a paradigm or perspective that considers

connections among different components, plans for the implications of their interaction, and requires transdisciplinary thinking”. The Institute of Medicine differentiates a systems approach to public health problems by the “new tools, including data, methods, theories, and statistical analysis different from those traditionally used in linear approaches”(Institute of Medicine, 2010, p. 74). Applying a systems approach to regional food security creates an opportunity to understand the problem in the context of its linkages to individual, intrapersonal, community, political and environmental factors (Institute of Medicine, 2010). While regional food security differs in definition and approach to other food security perspectives it is similar in that the ultimate goal is to meet peoples’ food needs. Therefore, using traditional measures of food insecurity still effectively quantify the problem (Joseph et al., 1997).

Food Insecurity and Health

According to the results from the Food Security Supplement survey conducted for the USDA’s Economic Research Service, food insecurity affected 17.5 million U.S. households, or 14.3% of all U.S. households in 2013 (Coleman-Jensen et al., 2014). In the Northeast region¹ of the U.S., between 2011 and 2013, an average of 12.9% of households (3.3 million households) were food insecure, lowest of all other regions (Coleman-Jensen et al., 2014). However, food insecurity has increased significantly in all 12 Northeast states and the District of Columbia since 2003 and at rates greater than the

¹ Based on the definition employed by federal agencies, the Northeast region includes (from north to south): Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia and the District of Columbia (Environmental Protection Agency, 2015; Northeast Regional Climate Center, 2015; United States Department of Agriculture, 2015b).

nation as a whole, signaling that food insecurity in the Northeast is growing (Coleman-Jensen et al., 2014). Prevalence of household food insecurity in the Northeast states is presented in Figure 1.1.

The links between food insecurity and physical and mental health problems are well documented. In adults, food insecurity has a paradoxical relationship with obesity and Type II diabetes, which are also linked with overconsumption (Adams, Grummer-Strawn, & Chavez, 2003; Crews et al., 2014; Drewnowski & Specter, 2004; Fitzgerald, Hromi-Fiedler, Segura-Pérez, & Pérez-Escamilla, 2011; Gucciardi, Vahabi, Norris, Del Monte, & Farnum, 2014; Larson, Story, & Nelson, 2009; Morland, Wing, Roux, & Poole, 2002; Pan, Sherry, Njai, & Blanck, 2012; Seligman, Bindman, Vittinghoff, Kanaya, & Kushel, 2007; Seligman et al., 2010; Swinburn, Caterson, Seidell, & James, 2007). This is likely due to coping strategies that include the consumption of cheaper, calorie-dense foods that can lead to weight gain. Food insecurity is associated with other chronic conditions such as hypertension, heart disease and kidney disease (Crews et al., 2014; Vozoris & Tarasuk, 2003).

In children, food insecurity is linked with obesity well as developmental conditions such as reduced bone density and nutrient deficiencies as well as diminished emotional and social functioning, and increased incidence of hospitalization (Alaimo, Olson, Frongillo, & Briefel, 2001; Casey et al., 2005; Cook et al., 2004; Cook & Frank, 2008; Eicher-Miller, Mason, Weaver, McCabe, & Boushey, 2011; Kaur, Lamb, & Ogden, 2015). Food insecure pregnant women have been found to have several micronutrient deficiencies including vitamins A, C and E (Brunst et al., 2014).

Additionally, food insecurity is also associated with maternal depression, in mothers with children younger than 36 months (Casey et al., 2004).

Food Insecurity and the U.S. Food System

A food system is a complex arrangement of drivers, activities and outcomes involved in transforming resources into consumable foodstuffs to feed a population (Ericksen, 2008a). An example of a food system and its components are presented in Figure 1.2. The ultimate goal of any food system is to provide food security to a specified population (Ericksen, 2008a). However, the degree to which this is accomplished varies significantly by the interactions between the components in that system. Over the last century food systems the U.S. food system has undergone major transformations that have increased production (Maxwell & Slater, 2003). Nonetheless, food insecurity persists. Continuing food insecurity is, therefore, frequently attributed to shortfalls in three areas: availability, access and utilization. The elements of availability and access are discussed below. However, utilization, which centers on food preparation, food storage and feeding practices is beyond the scope of this research.

Food Availability

Availability, as described by the World Food Programme is, “the amount of food that is present in a country or area through all forms of domestic production, imports, food stocks and food aid” (World Food Programme and Food and Agriculture Organization, 2009). In the U.S., at the national and regional level, the availability of food is currently stable. However, at community and household levels the availability of food is not homogeneous. For example, studies in cities such as Baltimore and Chicago demonstrate that predominantly Black and lower-income areas had lower measures of healthy food availability when compared with predominantly White, mixed race and higher-income areas (Block & Kouba, 2007; Franco, Diez Roux, Glass, Caballero, & Brancati, 2008). Research shows a similar pattern in racial minority and lower-income communities across the U.S. (Bodor, Rose, Farley, Swalm, & Scott, 2008; Bower, Thorpe, Rohde, & Gaskin, 2014; Chung & Myers, 1999; Hendrickson, Smith, & Eikenberry, 2006; Morland & Filomena, 2007; Morland et al., 2002; Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007; Zenk, Schulz, Hollis-Neely, et al., 2005; Zenk, Schulz, Israel, et al., 2005). Though much of the research on food availability has focused on the availability of healthy foods in urban areas, similar patterns were apparent in rural areas (Bitto, Morton, Oakland, & Sand, 2003; Champagne et al., 2007; Morton & Blanchard, 2007).

Some research suggests that differences in food availability in minority and low-income communities stem from a dearth of supermarkets and an abundance of small grocery and convenience stores (Bailey, 2010; Larson et al., 2009; Liese, Weis, Pluto, Smith, & Lawson, 2007; Powell et al., 2007; Rose & Richards, 2004; Walker, Keane, & Burke, 2010; Zenk, Schulz, Hollis-Neely, et al., 2005). However, other studies challenge

these results, finding that food availability and dietary patterns do not differ by the proximity to supermarkets (Elbel et al., 2015; Laska, Hearst, Forsyth, Pasch, & Lytle, 2010; Van Hulst et al., 2012).

Food Access

Access is primarily the economic ability to purchase food. This is demonstrated by the direct relationship between income and food insecurity in the U.S. In 2013, 42.1% of the 45.3 million households living in poverty experienced some form of food insecurity (Coleman-Jensen et al., 2014; DeNavas-Walt & Proctor, 2014). However, only 6.7% of those with incomes above 185% of the poverty line experienced food insecurity (Coleman-Jensen et al., 2014). Indirect relationships between income and food insecurity have also been assessed. For instance, households with children younger than six years were more likely to experience food insecurity (20.9%), compared to households without children (11.9%), suggesting that role that children have on economic resources (Coleman-Jensen et al., 2014). Ability to afford transportation can also be an indirect economic barrier to food access as studies in both urban and rural settings have shown (Bailey, 2010; Bitto et al., 2003; Liese et al., 2007; Morton & Blanchard, 2007; Rose & Richards, 2004; Webber, Sobal, & Dollahite, 2010; Zenk, Schulz, Israel, et al., 2005). However, other findings suggest that mode of transportation does not affect where shoppers purchase food (Morrison & Mancino, 2015).

Several studies have looked at the ways in which food insecurity manifests in communities with limited economic access. Larger households, particularly those with

young children spend significantly less per person on food than smaller households without children (Coleman-Jensen et al., 2014). Low-income shoppers were far less likely to consume the recommended amount of fruits and vegetables, possibly because these foods were more expensive in low-income areas than in other areas (Beydoun & Wang, 2008; Chung & Myers, 1999; Hendrickson et al., 2006; Stewart, Blisard, & Joliffe, 2003). In qualitative research price was identified as a primary consideration in the purchase of healthy foods (Webber et al., 2010). In quantitative research, when low-income households were given a larger food budget they spent more of their budget on healthier foods compared with high-income shoppers (Inglis, Ball, & Crawford, 2009). However, these findings run contrary to experimental and survey research that suggested educational attainment, the perception of food prices, and availability moderated the effect of income (Epstein et al., 2012; Giskes, Van Lenthe, Brug, Mackenbach, & Turrell, 2007; Handbury, Rohkovsky, & Schnell, 2015).

The Supplemental Nutrition Assistance Program (SNAP, formerly food stamps), the Supplemental Nutrition Program for Women, Infants, and Children (WIC), and other government food assistance programs attempt to improve economic access to food for those under 130% and 185% of the federal poverty level, respectively. The eligibility requirements for programs like SNAP and WIC are based on the federal poverty level, which is determined by the income required to purchase a minimally nutritious diet (Cook & Frank, 2008; Johnson & Smeeding, 2012; U.S. Department of Health & Human Services, 2015). Therefore, those with limited economic access, despite government assistance, often encounter the problem of inadequate food (Coleman-Jensen et al., 2014; Cook & Frank, 2008). Shocks to the food system have the ability to exacerbate current

limitations in availability and access, and thus food insecurity, through disruptions in food production, processing and distribution.

Global Environment Changes and Food Insecurity

Food systems, and therefore food security, depend on natural resource inputs such as water and land and are subject to biophysical influences like climate. Currently, these factors are more likely the cause of food insecurity in developing areas of the world than in developed regions (Food and Agriculture Organization, 2015). However all food systems, including the U.S., are vulnerable to global environmental change (GEC), which could have adverse effects on food security (Ericksen, 2008b; Ingram, 2011) (See “GEC Drivers” in Figure 1.2). Three dominant areas of GEC in food systems research include water scarcity, land availability and climate change.

Food production is exceptionally water-dependent and water-intensive, accounting for 90% of global freshwater consumption (Food and Agriculture Organization, 2012). With population growth, demand for food is constantly increasing, as is the competition for water for agricultural use (Food and Agriculture Organization, 2012; Murray, 2013). Furthermore, the long supply chains needed to transport food to rapidly growing urban centers results in food waste, requiring increased food production and therefore greater pressure on water resources (Food and Agriculture Organization, 2012). Like water, the global stock of available farmland is also under pressure from various sources. Unsustainable agricultural practices have led to the desertification, erosion and salinization of productive farmland (Godfray et al., 2010; Nellemann et al.,

2009). Used and unused farmland is also reduced as infrastructure for urban development grows. In the U.S. between 1992 and 2002 approximately 18 hectares per hour were converted from productive farmland to non-agricultural development (Heller & Keoleian, 2003). Together agricultural degradation and non-agriculture development is estimated to reduce available farmland between 8% and 20% by 2050 (Nellemann et al., 2009).

Climate change is expected to exacerbate pressure on water supplies and land availability through changing precipitation patterns, the melting of glaciers and the rise of sea levels (Food and Agriculture Organization, 2012; Murray, 2013; Nellemann et al., 2009). Experts also suggest that climate change will have deleterious effects on food production through the spread of weeds and pests, disturbances to pollinators and disruptions to supply chains by extreme weather events (Murray, 2013; Rosenzweig & Tubiello, 2007; Schmidhuber & Tubiello, 2007). Some estimates demonstrate that the average increase in temperatures may increase aggregate food production but the positive impacts appear to be short-lived (Godfray et al., 2010; Intergovernmental Panel on Climate Change, 2014; Nellemann et al., 2009; Rosenzweig & Tubiello, 2007).

While the specific regional impacts from climate change are unknown, it is likely that the availability of and accessibility to food (and therefore, food security) in the U.S. will be affected (Lake et al., 2012; Murray, 2013; Tacoli et al., 2013). This is because of our dependence on global imports for approximately 20% of our food supply, including up to 50% of some produce items and more than 75% of seafood (Jerardo, 2013; Paci-Green & Berard, 2015). Collectively, the GEC described above have the potential to reduce global food production by up to 25% by 2050 (Nellemann et al., 2009). This vulnerability has prompted research on adaptations to the current U.S. food system in

order to provide resilience to GEC. This includes investigating the potential for more fully articulated regional food systems.

Regional Food Systems

There is no standard way to define a region. They can be based on geographic boundaries (e.g., the Delmarva Peninsula), environmental boundaries (e.g., watersheds or “The Rockies”), economic and political borders (e.g., European Union) or social and cultural constructions (e.g., “The South”). Furthermore, regions do not exist in isolation. They can overlap and can be nested within other regions. For example, the Delmarva Peninsula is part of the Chesapeake Watershed, the Mid-Atlantic and the Northeast. Similarly, regional food systems are just one stratum in a much larger nested food system, which includes many local systems and, in turn, regional systems are part of national and global food systems. Regions are especially relevant to food systems because of food systems are dependent on the natural resources within specific regions. What differentiates regional food systems is the emphasis on regionally-based food production, processing and distribution, which promotes capacity within the region and reduces the dependence on external causes of vulnerability (Clancy & Ruhf, 2010; Ruhf, 2015).

Specifically, Clancy and Ruhf define an ideal regional food system as:

a system in which as much food as possible to meet the population’s food needs is produced, processed, distributed, and purchased at multiple levels and scales

within the region, resulting in maximum resilience, minimum importation, and significant economic and social return to all stakeholders in the region. (2010, p.1)

Potential Advantages of Regional Food Systems

Regional production, processing and distribution are currently operational but not at the necessary scope. Therefore, fully articulated regional food systems are aspirational but may provide specific advantages if they become more fully articulated. First, regional food systems may be beneficial from an environmental perspective. Compared with local food systems, the regional scale offers a much larger land base for agriculture (Bowell et al., 2014; Brown & Miller, 2008; Clancy & Ruhf, 2010; Connolly, Markey, & Roseland, 2011; Lengnick, Miller, & Marten, 2015; Peters, Wilkins, & Fick, 2007; Pretty, Ball, Lang, & Morison, 2005). A more fully developed regional food system may also offer greater diversity in the foods produced because of variations in climate, soils and crops (Lengnick et al., 2015; Liverman & Ingram, 2010). Diversity in food production allows for increased flexibility and adaptation to changing growing conditions stemming from GEC (King, 2008). Furthermore, diverse food production itself provides environmental benefits including greater biodiversity, increased soil quality and improved water usage, that may reduce GEC (Kremen & Miles, 2012).

Second, the regional scale may provide significant infrastructure efficiencies. International and national food supply chains rely heavily on the existence of cheap fossil

fuels to transport food over long distances (Paci-Green & Berard, 2015). Local food supply chains are much shorter but, because of their scale, are not necessarily more energy-efficient (Pirog, Pelt, Enshayan, & Cook, 2001). Therefore, supply chains at the regional scale may be the optimal scale for food distribution (Clancy & Ruhf, 2010; Hance, Ruhf, & Hunt, 2006; Lengnick et al., 2015). Additionally, regional supply chains may reduce the impact of acute disruptions to national and global supply chain infrastructure stemming from GEC (Lengnick et al., 2015; Paci-Green & Berard, 2015). Finally, regional food systems can offer benefits from the governmental perspective. Regions may be the ideal scale to manage natural resources for food production (Clancy & Ruhf, 2010; Hance et al., 2006; Lengnick et al., 2015). Resources such as rivers, lakes, mountain ranges, forests, and prairies often cross local and state political boundaries. Similarly, food supply chains and their requisite infrastructure span these borders. Both inputs and activities may be better suited for regional public and private sector governance, thereby simplifying collaboration. Such collaboration may be advantageous in linking urban markets and rural agricultural areas (Ruhf, 2015).

A Future Northeast Regional Food System

The Northeast is an appropriate setting for research into emerging regional food systems because it includes several large metropolitan areas that create high demand for food. However, the region also has plentiful water resources and several micro-climates that have the ability to support diverse agricultural products (Hance et al., 2006). Furthermore, the transportation infrastructure of the Northeast consists of well-developed

highway, rail and sea transport systems that allow both rural and urban areas to be connected (Hance et al., 2006; Ruhf, 2015). There are also several examples of regional governance mechanisms that are already in place, with land and water resources frequently managed at the regional level (e.g., the Appalachian Region and the Chesapeake Bay watershed) (Appalachian Regional Commission, 2015; Chesapeake Bay Foundation, 2015). Furthermore, regional food policies, agricultural projects and advocacy are increasing steadily increasing (Bowell et al., 2014; Northeast Sustainable Agriculture Working Group, 2015). Despite emerging research on Northeast regional food system, little is understood about the food needs within the region, an essential component of providing regional food security. This research attempts to fill that gap by investigating the dietary characteristics of the Northeast.

THEORETICAL FOUNDATIONS

Ecological Systems Theory

The Ecological Systems Theory (EST) will provide the foundation for the investigation of the food needs of the Northeast. The EST is a widely applied theory by which many health behaviors can be understood. The theory proposes assessing behaviors within the many environments in which they exist (Bronfenbrenner, 1977). Bronfenbrenner (1977) describes a system of nested and interacting contexts, that when examined holistically, gives greater insight and interpretation into the drivers of

behavioral outcomes. He states that, “environmental structures, and the process taking place within and between them, must be viewed as interdependent and must be analyzed in systems terms” (Bronfenbrenner, 1977, p. 518). Further development of this theory, specific to health behaviors, allows for a more explicit application of EST by describing the specific *levels of influence* within such a system that can promote or inhibit patterned behaviors (McLeroy, Bibeau, Steckler, & Glanz, 1988). In this way, the EST can be used to investigate the sociodemographic determinants at the *intrapersonal*, *interpersonal*, *community* and *public policy* levels that influence behaviors within a food system context. Figure 1.3 presents a framework depicting the levels of influence relevant to dietary characteristics. Because regional food security emphasizes self-reliance, an additional *environmental* level is included to represent the role of land use and agricultural production.

It is important to emphasize that food security in itself is not a behavior, rather a condition that results from one’s dietary characteristics. These characteristics are influenced by factors at several levels of influence. At the *intrapersonal* level, for example, income is a powerful determinant of what individuals can afford to purchase (Beydoun & Wang, 2008; Stewart et al., 2003). The literature suggests that other intrapersonal factors such as age, gender and education also play a role in what foods people purchase (Handbury et al., 2015; Ricciuto, Tarasuk, & Yatchew, 2006). Additionally, race and ethnicity have been shown to be predictors of variations in food purchasing (Calloway et al., 2016; Cullen et al., 2007).

Variations in food dietary characteristics also vary at the *intrapersonal* level as a result of household factors. The number of members in a household has been shown to

have an influence on the type and amount of food that is purchased, but so has the presence of children in the household (Rankin et al., 1998; Yoo et al., 2005). For example, the taste preferences of children has shown to play a major role in the dietary characteristics of low-income food shoppers (Zachary, Palmer, Beckham, & Surkan, 2013). However, there is research to suggest that the same effects may not be seen in the food purchases of higher-income individuals (Daniel, 2016).

At the *community* level, the retail food environment is the primary manner in which individuals procure food. Research by the USDA finds that regardless of income, 90% of all consumers do their primary food shopping at a supermarket or supercenter (Morrison & Mancino, 2015). However, the proportion of supercenters, supermarkets, small grocery stores and convenience stores may vary by community (Bower et al., 2014). The literature shows that these community level differences produce variations in availability and affordability of foods that can result in different dietary patterns (Block & Kouba, 2007; Bodor et al., 2008; Franco et al., 2008; Morland & Filomena, 2007; Zenk, Schulz, Hollis-Neely, et al., 2005).

The *public policy* level of influence affects dietary patterns through specific mechanisms. For instance, federal food programs such as the SNAP and WIC (WIC), and other government food assistance programs attempt to improve economic access to food. (Coleman-Jensen et al., 2014). Additionally, the federal government issues regular guidance regarding what they consider to be a healthy diet (U.S. Department of Health & Human Services and U.S. Department of Agriculture, 2015). The *environmental* level has a direct impact on food purchasing being that land and agriculture interact to produce food. However, policy can also indirectly influences dietary characteristics through

USDA policies like crop subsidies that make some types of foods more abundant and affordable (Popkin, 2011).

PUBLIC HEALTH SIGNIFICANCE

Food insecurity remains a problem in the U.S., and a growing problem in the Northeast region. It is likely to be exacerbated by changes to the global environment that result in widespread food system disruptions. Given the possible changes to the current U.S. food system, new approaches to providing adequate food are necessary. More robust regional food systems may have the potential to improve regional food security in the wake of GEC and its effects. However, research on regional food systems has not sufficiently investigated the role of demand-side factors such as dietary characteristics. The purpose of this research is to explore the dietary characteristics of the Northeast U.S. within the context of a future regional food system. This research may have implications for public health and food system researchers and advocates, and food supply chain participants.

SPECIFIC AIMS

Aim 1: Describe characteristics relevant to regional food security in the Northeast.

Aim 2: Explore dietary characteristics in the Northeast region and their associations with sociodemographic factors.

Aim 3: Identify specific dietary patterns using a regionally significant market basket and their associations with sociodemographic factors.

DISSERTATION OVERVIEW

The research presented here explored dietary characteristics in the Northeast to better understand regional food security. Chapter 2 provides the research methodology for Aims 1, 2 and 3. Findings from Aims 1, 2 and 3 are presented in Chapters 3, 4 and 5, respectively. Finally, a summary of findings, their implications and recommendations for future research is presented in Chapter 6.

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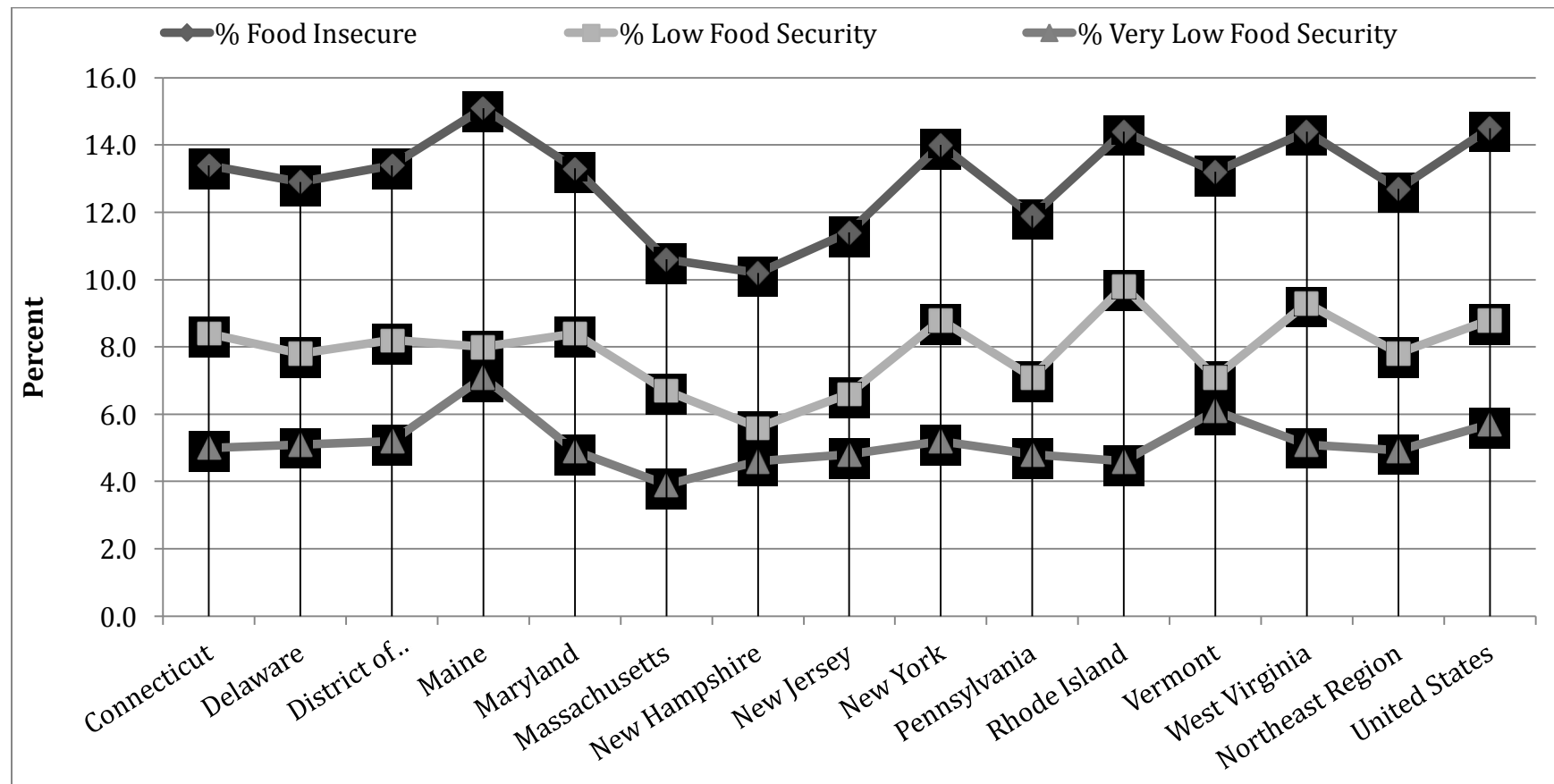
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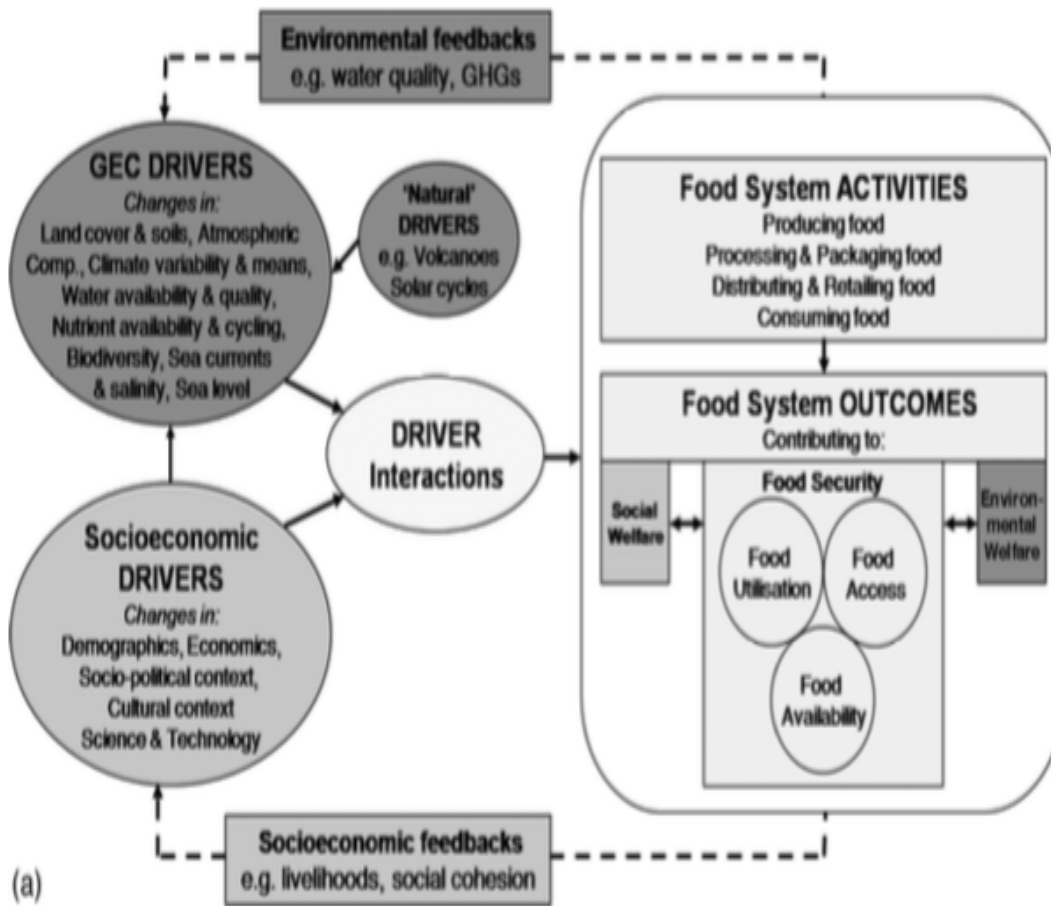
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Figure 1.1 Household Food Insecurity in the Northeast United States ^a



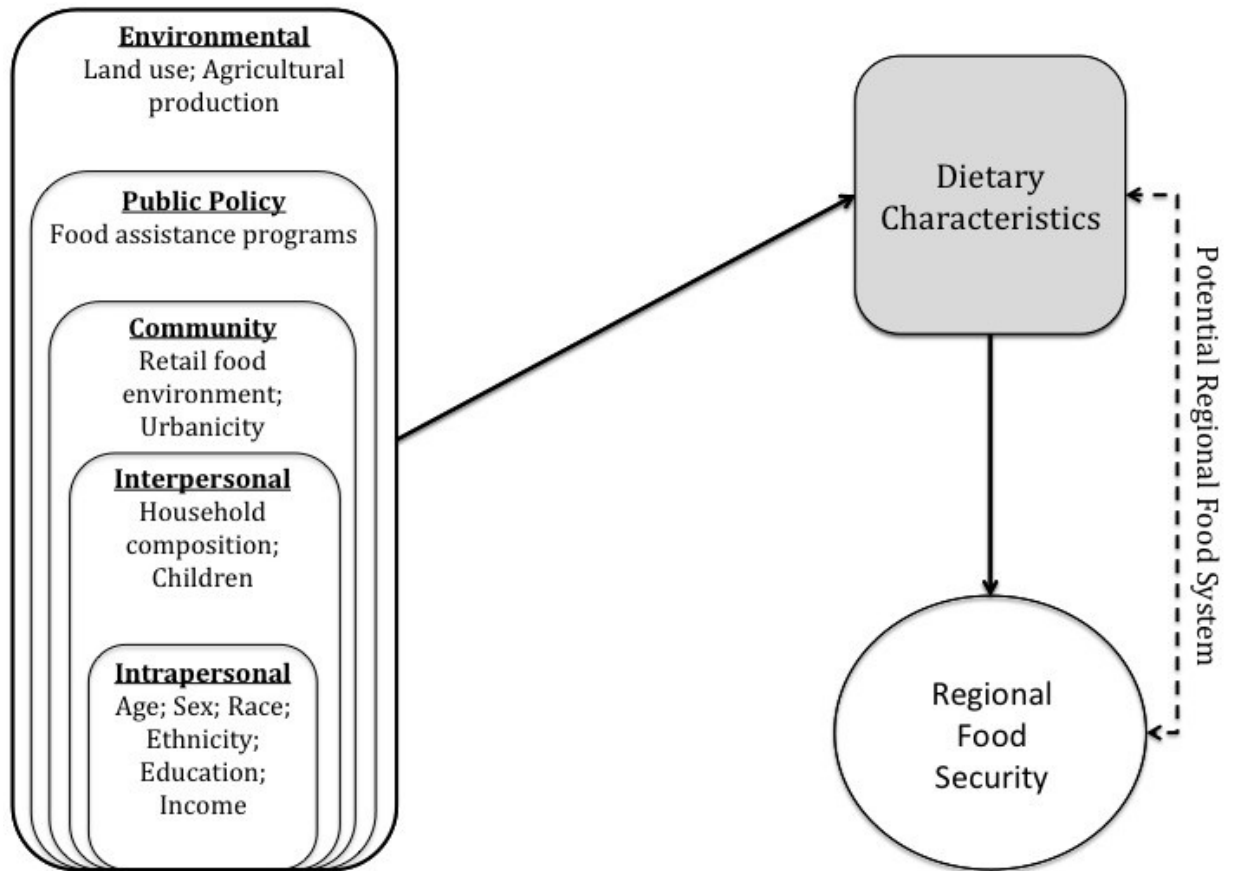
^a (Coleman-Jensen et al., 2014)

Figure 1.2 Food System Components ^a



^aAdapted from Ingram, Ericksen & Liverman (2010)

Figure 1.3 Application of Ecological Systems Theory to Regional Food Security^a



^aAdapted from McLeroy et al. (1988)

CHAPTER 2
RESEARCH METHODS

RESEARCH METHODS

This chapter describes the study design, sampling, data collection and analysis used for Aims 1, 2 and 3. These methods are also provided in Chapters 3, 4 and 5, respectively.

Aim 1: Describe characteristics relevant to regional food security in the Northeast.

Data Sources

Several publicly available data sets were used to explore sociodemographic and food production characteristics in the Northeast. Sociodemographic data were obtained from the American Community Survey unless noted otherwise. Five-year estimates were used because they provided a larger sample size and greater reliability than one and three-year estimates. Whenever possible data from the year 2012 were used to provide consistency with data in Chapters 4 and 5. In cases where 2012 data were not available, data from the closest available year were used.

National and Regional Sociodemographic Data

Population size, sex, age, race, ethnicity and educational attainment data were obtained from the Social Characteristics Profile of the 2012 ACS (United States Census

Bureau, 2012a). Median household income and the percentage of people living below poverty came from the Economic Characteristics Profile of the 2012 ACS (United States Census Bureau, 2012b). Unemployment data were obtained from the Bureau of Labor Statistics from June 2012 (Bureau of Labor Statistics, 2012). Household composition data were obtained from the 2012 ACS Housing Characteristics Profile (United States Census Bureau, 2012c).

Urbanicity and population density data were obtained from the 2010 Decennial Census because these data are not collected in the ACS (United States Census Bureau, 2010c). The U.S. Census Bureau defines urban areas as areas with at least 50,000 people and rural areas are defined as areas with less than 50,000 people (United States Census Bureau, 2010b). Retail food environment data were obtained from the 2012 U.S. Census Bureau County Business Patterns (United States Census Bureau, 2012d). Data for supermarkets and grocery stores, convenience stores, meat markets, fish and seafood markets and fruit and vegetable markets were gathered by North American Industry Classification codes. Farmers' market data came from the 2016 USDA Farmers Market Directory, which was the only year available (United States Department of Agriculture, 2016a).

Data on households receiving SNAP were obtained from the Economic Characteristics Profile of the 2012 ACS (United States Census Bureau, 2012b). Data on the number of women participating in WIC came from USDA's Food and Nutrition Service 2012 WIC program data (United States Department of Agriculture, 2012b). Data on the number of students participating in the National School Lunch Program (NSLP) and School Breakfast Program (SBP) were obtained from the USDA's Food and

Nutrition Service 2012 child nutrition data (United States Department of Agriculture, 2012a).

Land Use, Agricultural Production and Regional Self-Reliance

Regional land use, agricultural production and regional self-reliance data were retrieved from two sources. Land use data were from USDA Economic Research Service land use database, which was last collected 2007. Agricultural production figures and regional self-reliance data were obtained by research from Timothy Griffin at Tufts University (T. Griffin, personal communication, January 12, 2017). Regional self-reliance was computed using consumption and production data. Griffin and colleagues obtained agricultural production information for all crops and major livestock in the Northeast region from 2001 to 2010 (Griffin, Conrad, Peters, Ridberg, & Tyler, 2014). Sources for agricultural production data included USDA National Agricultural Statistics Service (NASS) Surveys, USDA NASS Agricultural Censuses, State Departments of Agriculture annual reports and State Departments of Agriculture specialty crop reports, research trials at land grant universities, regional yield data and personal communication with experts (Griffin et al., 2014). Consumption data were obtained from the Food Availability Data System at the USDA Economic Research Service. Estimates were acquired by, “subtracting annual exports from the annual sum of beginning stocks, domestic production and imports of individual commodities, and dividing the resultant by the national population” (Griffin et al., 2014, p. 352). This annual per capita figure was then multiplied by the population per year in the Northeast to achieve regional

consumption. The regional self-reliance measure is a net balance and does not track flows of food from production to consumption.

Analysis

Exploratory analyses were conducted using sociodemographic data at the national and regional levels. Sociodemographics are presented in percentages, medians and means. Data used to represent national statistics were available at the national level and did not require aggregation from state-level data. Data representing the Northeast region included each of the 12 Northeast states and the District of Columbia and were generated by aggregating state-level data.

When raw data were not available at the state level, regional-level data were calculated using weights. Median age could not be aggregated for the region from state-level data. Therefore, median age for the Northeast was calculated using weights that reflect the proportion of total regional population for each state. Average household size for the region was calculated using a weighted average to account for variations in the number of households in each state. The density of retail food establishments was measured by calculating the number of retail establishments per 10,000 people. The percentage of women participating in WIC was calculated by dividing the number of women participating in WIC by the total number of women in the nation and region, respectively. Data for NSLP and SBP were divided by total school enrollment data for 2012 obtained from the National Center Educational Statistics to calculate the percentage

of students participating in the programs (National Center for Educational Statistics, 2012).

Land use data was aggregated from the state level to the regional level. Regional self-reliance measures were calculated for foods in the 12 categories and sub-categories from the USDA *What We Eat in America* from the National Health and Nutrition Examination Survey (United States Department of Agriculture, 2016b). Raw data were used to calculate regional self-reliance figures for milk and dairy, meats, poultry, seafood, eggs, cured meats and non-meat proteins. Findings for grains, fruit and vegetables were drawn from the parent study because a substantial amount of data for these items could not be re-categorized (Griffin et al., 2014). Data for snacks and sweets and mixed dishes categories could not be used due to significant processing. Production and consumption data for the USDA categories are presented in pounds. Regional self-reliance is estimated as the proportion of regional consumption that is satisfied by regional production and is presented as a percentage or:

$$\text{Total Regional Production} / \text{Total Regional Consumption} \times 100$$

Aim 2: Explore dietary characteristics in the Northeast region and their associations with sociodemographic factors.

Data Sources

Consumer Expenditure Survey Diary Survey

Data used in this study were from the Bureau of Labor Statistics Consumer Expenditure Diary Survey for 2012 through 2014 (referred to as the Diary Survey from here on) (Bureau of Labor Statistics, 2016a). The Diary Survey is a continuously operating survey that collects data on U.S. households and their purchasing characteristics. The Diary Survey uses nationally and regionally representative probability samples of U.S. households composed to be representative of the civilian, non-institutionalized population (Bureau of Labor Statistics, 2016a). Sampling characteristics of households participating in the Diary Survey for years 2012 through 2014 are presented in Table 2.2. Participating households are recruited through the mail and data collection is conducted through face-to-face interviews and paper survey (Bureau of Labor Statistics, 2016b).

The Diary Survey includes two unique survey components; the Household Characteristics Questionnaire and the Expenditures Diary. The Household Characteristics Questionnaire is conducted as a face-to-face interview to collect information about sociodemographic characteristics for the primary respondent and all household members (Bureau of Labor Statistics, 2015). Primary survey respondents are considered to be the

head of household (Bureau of Labor Statistics, 2016a). The Expenditures Diary is a paper form used to collect purchasing data for 104 items purchased over two consecutive one-week periods (Bureau of Labor Statistics, 2013). The Expenditures Diary is used to collect expenditure data for frequently purchased items, including food for home consumption. The Household Characteristics Questionnaire and the Expenditures Diary can be matched through common ID numbers to generate a single dataset that includes sociodemographic characteristics and information on food purchased for home consumption. For this study, purchasing was used as a proxy for consumption.

Study Population

Data for this research were obtained by linking the Household Characteristics Questionnaire and the Expenditures Diary for every quarter in 2012, 2013 and 2014. Each quarterly dataset was checked for compatibility of variables and discrepancies were removed to establish consistency. Non-matched observations (n=7,402), non-Northeast states (n=506,543), observations with missing state identifiers (n=94,471), and observations with only one week of purchasing data (n=368) were removed. The final dataset included 3,428 household observations.

Analysis

Variable Definitions

The primary survey respondent reported the sociodemographic characteristics of themselves and their household. Select variables included: sex of the primary respondent (coded as male=0 and female=1); age of the primary respondent (coded as the respondents age divided by five to represent five year intervals); race of the primary respondent (coded as White=1, Black=2, Asian=3 and Other=4); ethnicity of the primary respondent (coded as non-Hispanic=0 and Hispanic=1); education of the primary respondent (coded as less than a college education=0 and college education and above=1); household income (coded as the household income divided by 10,000 to represent \$10,000 intervals); children younger than 18 in the household (continuous); household members older than 64 (continuous); and household participation in SNAP in the last 12 months (coded as no=0 and yes=1).

Purchasing data on the 104 items from the Diary Survey's were categorized into 12 categories and sub-categories from the USDA *What We Eat in America* methodology used in the National Health and Nutrition Examination Survey national food survey (United States Department of Agriculture, 2016b). Twenty-seven of the original Diary Survey items could not be categorized into the USDA categories and were, therefore, dropped (Table 2.1). The 12 USDA categories were used as outcome variables. Each of the 12 outcomes were treated as a binary variable and were coded as a zero "0" if there

were no purchases within that category over the two consecutive week sampling interval and a one “1” if there was a purchase within that category.

Statistical Analyses

Multivariate logistic regression analyses were conducted to estimate the associations between sociodemographic characteristics and the purchasing of the 12 food categories. These analyses produced adjusted odds ratio (ORs), 95 percent confidence intervals (95% CI) and p-values. An alpha of 0.05 was used as a threshold for significance. The variables of sex, age, race, ethnicity, education, household income, children younger than 18, household members older than 64 and SNAP participation were included in the final models.

Several models were tested for each of the 12 outcomes before deciding on the final models. Several interaction terms using the final covariates were also created to measure effect modification. The interaction term for education and household income was the only interaction that showed consistent effect modification, so it was retained in the final model. Likelihood ratio tests also indicated that this interaction significantly improved model fit for seven of the 12 models. Covariates were also checked for collinearity. Household size was initially included in the models but was dropped because it was collinear with the number of children younger than 18 in the household ($r = .80$). All other covariates exhibited low variance inflation factors. All analyses were conducted using Stata Version 12 (StataCorp, 2011).

Aim 3: Identify specific dietary patterns using a regionally significant market basket and their associations with sociodemographic factors.

Study Design

The Enhancing Food Security in the Northeast (EFSNE) study was a USDA-funded multi-institutional research project, which aimed to better understand whether greater reliance on regionally produced foods can improve food access for low-income communities while also benefiting farmers, food supply chain firms, and others in the food system. From March 2011 through December 2015, project staff engaged in recruitment, data collection and analysis activities across multiple project initiatives, including the supply chain of production, distribution and consumption. The research and results presented here pertain to the consumption initiative, which focused on the demand-side characteristics of a regional food system.

Sampling and Recruitment

The population for this study was residents of the Northeast. Data collection took place at supermarkets throughout the region. Sampling of stores was conducted using a convenience sampling strategy and was based on previous relationships with and proximity to one of the participating EFSNE institutions. These criteria were considered necessary based on the intensive data collection process for the overall project. To be eligible the stores had to meet the definition of a supermarket and had to sell all of the

EFSNE market basket foods. The Food Marketing Institute definition of a supermarket (sells groceries, meat and produce and has at least \$2 million in annual sales) was used to determine eligibility (Food Marketing Institute, 2015). The convenience sample recruited a mix of stores in low and middle-income areas. The final study sample consisted of 15 supermarkets in nine study locations in six Northeast states. Customers were then sampled from each of the participating supermarkets (Appendix C.1).

The study aimed to recruit a sample of 100 customers from each supermarket in each of three rounds of data collection. A non-probability sampling strategy was used to recruit participants. Potential participants were actively recruited upon exiting the supermarket and were approached about answering question regarding their food purchasing habits and demographic information for a survey lasting five to seven minutes. Those who agreed to participate were screened for eligibility. In all three rounds of data collection eligibility criteria included being at least 18 years of age and being the primary food shopper in their household. For Round 1, eligibility criteria also included purchasing groceries at that supermarket that day and being a resident of the neighborhood surrounding the supermarket. Initially, the EFSNE team believed these criteria would restrict the sample to those who used the supermarket as their primary source of food. After Round 1, we learned that the supermarkets attracted customers from inside and outside the surrounding neighborhood. Therefore, these criteria were removed for Rounds 2 and 3.

To avoid a biased sample, recruitment occurred in mornings, afternoons and evenings and in nine of the 12 months. Recruitment was also conducted during both the monthly SNAP benefit cycle and outside of the cycle (e.g., in Maryland, during this time,

SNAP benefits were distributed between the 6th and 15th of the month). Participants determined eligible were provided with the purpose, procedures, benefits and voluntary nature of the research and were then asked to give verbal consent to participate. Oral consent was used instead of written consent in an effort to maintain anonymity. As compensation for their time, in Rounds 2 and 3, participants were provided with \$5 gift cards to the supermarket.

Data Collection and Instruments

From November 2012 through April 2015 EFSNE researchers conducted three rounds of data collection at the 15 supermarkets. Some of the study supermarkets did not participate in every round of the study due to attrition. Twelve supermarkets participated in Round 1 and 14 supermarkets participated in Rounds 2 and 3. Eleven supermarkets participated for all three rounds of data collection. In three instances a store was lost to attrition and replaced by a nearby store.

The customer survey consisted of 25 questions and was administered face-to-face immediately outside the supermarket. Survey items consisted of demographic and household characteristics, perceptions about their neighborhood's food environment and their purchasing of eight specific market basket foods (Appendix C.2). The customer survey had high face and content validity. The data collector read the questions and wrote responses on a paper copy of the survey. In total, 2,887 customer surveys were administered across all three rounds of data collection. Between Rounds 1 and 2 of data collection, the eligibility criteria and the wording of questions related to food purchases

changed. Therefore, data from Rounds 2 and 3 are systematically different from those in Round 1. For this reason only data from Rounds 2 and 3 were used for analysis and included 1,996 participants.

Selection of Market Basket Items

A market basket is a commonly used instrument designed to represent a total diet in nutrition and diet research, though their size and composition vary depending on the research objectives. The USDA-recommended Thrifty Food Plan, for instance, is a market basket used for the development of food and nutrition policy in the U.S. and is frequently used as the foundation for smaller market basket analyses in research in specific populations (Anderson et al., 2007; Jetter & Cassady, 2006; Neault, Cook, Morris, & Frank, 2005). Some studies have used market basket analyses to compare the availability of items in different communities, while others have designed them based on factors such as popularity, convenience, healthfulness and food contamination (Block & Kouba, 2007; Burns, Gibbon, Boak, Baudinette, & Dunbar, 2004; Norton et al., 2015; Short, Guthman, & Raskin, 2007).

This research employs the market basket created for the EFSNE project, which was designed to reflect foods significant to a Northeast regional food system. The research team selected staple items from every food group in the USDA Food Guidance System (fruits, vegetables, grains, protein and dairy) (United States Department of Agriculture, 2015b). A combination of fresh and processed items was selected because processing is critical to extending the growing season and increases profits for the supply

chain. Finally, seeking to assess food purchasing in a regional food system context, the team selected items based on their current and past (and therefore, future) capability to be produced in the Northeast region. EFSNE team members measured the regional self-reliance, the net balance between the regional production and regional consumption of the food, from 2001 to 2009. Regional self-reliance figures are presented as percentages and indicate the extent to which production can satisfy demand for each item (Griffin et al., 2014). The final market basket consisted of eight items: milk, ground beef, bread, apples, canned peaches, frozen broccoli, cabbage, and fresh potatoes. A brief rationale for each of the market basket items is provided below.

Milk

Fluid milk was selected due to its popularity as a staple dairy product. All states in the region had functional dairy farms as of 2013, and New York and Pennsylvania were among the top five milk producing states in the nation (United States Department of Agriculture, 2015a). The regional self-reliance for fluid milk was 76%.

Ground Beef

Ground beef constitutes 63% of the total food service beef and 49% of total retail beef volume in the U.S., making it a staple protein item (Speer, Brink, & McCully, 2015). Though the Northeast is not a top producer of beef cattle, the production of milk in New York and Pennsylvania contribute to ground beef production through the culling of dairy

cattle. According to a report in 2009, approximately 18% of beef production comes from culled dairy, most of which is used for ground beef (Lowe & Gereffi, 2009). The regional self-reliance for all beef was 16%.

Bread

Wheat is grown in the Northeast, but no state in the region was a top 10 producer from 2012 to 2014 (United States Department of Agriculture, 2015a). The EFSNE team assumed that the bread available in the project stores was made with wheat flour grown outside the region, but had been likely baked and distributed within the region. It was not possible to calculate the regional self-reliance for wheat or bread.

Apples

In 2014, the Northeast produced approximately 12% of the nation's fresh apples. New York and Pennsylvania were both in the top five of apple producing states (United States Department of Agriculture, 2015a). The regional self-reliance for fresh apples was 81%.

Canned Peaches

Peaches were selected because they are the most popular canned fruit consumed in the U.S. Peaches grown in the Northeast account for approximately 5% of the U.S.

processed peach production by volume (United States Department of Agriculture, 2015a). Regional self-reliance for fresh and processed peaches was 26%.

Frozen Broccoli

The majority of broccoli grown for the fresh market in U.S. is grown in California and Arizona; up to 98% depending on the season. However, it is also grown in five Northeast states where it accounts for approximately 11% of total production in the summer and fall (Atallah & Björkman, 2014). The regional self-reliance for broccoli was 1% and all of the frozen broccoli in the stores we studied was grown overseas.

Cabbage

Cabbage is the fourth highest value crop produced in the region. In 2013, New York was the second leading cabbage producer in the U.S., behind only California (United States Department of Agriculture, 2015a). The regional self-reliance for cabbage was 105%, which indicates that production was greater than consumption.

Fresh Potatoes

As of 2014, the Northeast accounted for approximately 9% of the nation's potato production. Maine accounted for approximately 65% of the potatoes produced in the

Northeast (United States Department of Agriculture, 2015a). The regional self-reliance for fresh potatoes was 38%.

Analysis

Variable Definitions

Variables were selected for data analysis based on their significance in the food security and nutrition literature. Participants were asked several questions about their sociodemographic and household characteristics. The following were open-ended questions: participants age (coded as continuous but divided by five to represent five year intervals); participants education in years (coded continuous) and number of children under five years of age for which they shop (continuous).

The stores' urban/rural designation was assessed using 2010 Census Bureau urban and rural designations (United States Census Bureau, 2010a). The rural variable was indicated by a binary variable, coded as 0 for urban areas and 1 for rural areas. They were also asked to indicate their gender with a binary response, coded as 0 for male and 1 for female. Participation in public assistance was measured by asking if participants or anyone in their household participated in any of the following programs: SNAP, WIC, The National School Lunch or National School Breakfast programs, Supplemental Security Income and Head Start. Responses were recorded and coded 0 for no and 1 for yes. An interaction term was created to test for effect modification between education and public assistance participation, but it was not included in the final model because it did

was not statistically significant in any of the models. Finally, participants were asked if they purchased each of the eight market basket items in the past 30 days. Responses are scored as a binary, coded 0 for no and 1 for yes. The eight responses served as the outcomes for the analysis.

Statistical Analyses

The analyses for this research include two latent variable techniques: latent class analysis and latent class regression. Latent class analysis is an analytic method used to identify unobserved subgroups or classes from observed categorical responses. For this research, latent class analysis was conducted using the eight dependent binary variables in order to investigate the patterns in which they were purchased. First, models with two, three, four, five and six classes were fit. Based on model diagnostics, the model that best fit the data was selected. For model diagnostics with p-values, an alpha of 0.05 was used as a threshold for significance.

Parameter estimates were then used to interpret the meaning for each of the classes in the model. Latent class probabilities represent the probability that an individual is a member of a certain class. Using latent class probabilities the number of members in each class can be calculated. Conditional probabilities represent the probability that an individual purchased each of the eight market basket items, for each class. From conditional probabilities for each class, distinct patterns can be interpreted. Standard errors for conditional probabilities were used to assess the reliability of the parameter estimate.

Next, the selected model was used in latent class regression models in order to assess predictors of being a member in one class versus another class. These analyses produced odds ratio (ORs), 95 percent confidence intervals (95% CI) and p-values. An alpha of 0.05 was used as a threshold for significance. The variables of sex, age, education, store location and participation in public assistance were selected for use in the final regression model. The regression models were specified with 2000 starting values and the *Cluster* command was used to account for associations within the stores. Because of missing covariates, 155 observations were dropped from the final regression analyses. All analyses were conducted using Mplus Version 7 (Muthén & Muthén, 2015)

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Table 2.1 Categorization of USDA Food Categories and Bureau of Labor Statistics Diary Survey Items

USDA Category ^a	Diary Survey Items ^b
Milk and dairy	Fresh milk; cheese; other dairy products including powdered milk and fresh, canned and non-frozen yogurt
<i>Proteins</i>	
Meats	Ground beef; chuck roast; round roast; other roast; round steak; sirloin steak; other steak; other beef; pork chops; ham; other pork; lamb and organ meats; mutton, goat and game
Poultry	Fresh and frozen whole chicken; fresh or frozen chicken parts; other poultry
Seafood	Canned fish, seafood and shellfish; fresh fish and shellfish; frozen fish and shellfish
Eggs	Eggs
Cured meats	Frankfurters; bologna, liverwurst, salamis; other lunchmeat; bacon; pork sausage; canned ham
Non-meat proteins	Dried peas; dried beans; canned beans; nuts
Grains	Flour; prepared flour mixes; cereal; rice; pasta, cornmeal, other cereal products; white bread; bread other than white; fresh biscuits, rolls, muffins
Fruit	Apples; bananas; oranges; other fresh fruits; citrus fruits; frozen fruits; canned fruits; dried fruits
Vegetables	Potatoes; lettuce; tomatoes; other fresh vegetables; frozen vegetables; canned corn; miscellaneous canned vegetables; other processed dried vegetables; dried carrots, onions, leafy greens and cabbage; prepared salads
Snacks and sweets	Ice creams and frozen yogurt; cakes and cupcakes; cookies; crackers; bread and cracker products; doughnuts, sweet rolls, coffeecakes; frozen, refrigerated and canned bakery products; fresh pies, tarts and turnovers; candy and chewing gum; potato chips and other snacks; prepared desserts
Mixed dishes	Soup; frozen meals; frozen prepared food; baby food; miscellaneous prepared foods

^a (United States Department of Agriculture, 2016b)

^b (Bureau of Labor Statistics, 2013)

Table 2.2 Households Participating in Bureau of Labor Statistics Diary Survey
Compared with Northeast Households

	Households participating 2012 – 2014 ^a	Households participating as portion of total	Households as portion of Northeast
Connecticut	235	6.9%	5.6%
Delaware	43	1.3%	1.4%
District of Columbia	25	0.8%	1.1%
Maine	93	2.7%	2.3%
Maryland	257	7.5%	8.7%
Massachusetts	320	9.3%	10.2%
New Hampshire	52	1.5%	2.1%
New Jersey	521	15.2%	13.0%
New York	947	27.6%	29.5%
Pennsylvania	930	27.1%	20.3%
Rhode Island	0	0%	1.7%
Vermont	0	0%	1.1%
West Virginia	5	0.1%	3.0%
<i>Northeast Region</i>	3,428	100%	100%

^a (Bureau of Labor Statistics, 2013)

Table 2.3 Sampling Characteristics of Supermarkets Participating in EFSNE

<u>Location</u>		<u>Characteristics</u>		<u>Participation</u>	
<i>State</i>	<i>City/County</i>	<i>Urban/ Rural</i>	<i>Poverty Rate</i>	<i>Round 2</i>	<i>Round 3</i>
Delaware	Sussex County	Rural	14.5%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Delaware	Sussex County	Rural	14.8%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Maryland	Baltimore City	Urban	40.5%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Maryland	Baltimore City	Urban	20.5%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	Madison County	Rural	11.4%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	New York City	Urban	28.3%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	New York City	Urban	28.3%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	Syracuse	Urban	39.1%	<input type="checkbox"/> ✓	
New York	Syracuse	Urban	5.9%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	Onondaga County	Rural	8.7%		<input type="checkbox"/> ✓
Pennsylvania	Pittsburgh	Urban	10.0%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Vermont	Essex	Rural	20.2%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Vermont	Essex	Rural	20.2%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
West Virginia	Charleston	Urban	20.1%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
West Virginia	Charleston	Urban	20.1%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓

Note: ✓ Participated in data collection

CHAPTER 3
MANUSCRIPT 1:
RELEVANT CHARACTERISTICS OF REGIONAL FOOD SECURITY IN THE
NORTHEAST

ABSTRACT

Introduction

Global environmental changes could have adverse effects on existing food systems and exacerbate food insecurity in the Northeast United States. Expanding regional food systems may be able to improve regional food security in the face of these changes. To date, limited research has focused on the food needs of the region.

Objective

This review summarized characteristics of the Northeast to begin to understand the food needs of the region and the possibility for an emerging regional food system to help meet those needs.

Methods

Publicly available sociodemographic, land use and agricultural production data were used to characterize the region from two perspectives. Regional production and consumption data were also utilized to measure regional self-reliance in several food categories.

Results

Results indicated that compared with the nation as a whole, the Northeast differed on several sociodemographic factors including age, sex, ethnicity, education, income and participation in federal food assistance programs. Land use and agriculture production data revealed opportunities for developing a regional food system. Production and

consumption data demonstrated wide variations in regional self-reliance by food category.

Conclusions

This research demonstrated the unique sociodemographic characteristics of the Northeast and the potential that the region may have for building a more robust regional food system. Future research should assess dietary characteristics at the regional level.

INTRODUCTION

Accessibility and availability of adequate food remains a problem in the United States, despite advances in food production, processing and distribution. According to the United States Department of Agriculture definition of food security, “access by all people at all times to enough food for an active, healthy life”, 14.3% of America households were food insecure as of 2013 (Coleman-Jensen, Gregory, & Singh, 2014, p. 2). In the Northeast region of the U.S.², food insecurity is rising faster than national levels since 2003 (Coleman-Jensen et al., 2014). Food insecurity is associated with a higher risk of diet-related diseases in individuals, making it a significant risk factor of morbidity and mortality (Seligman, Laraia, & Kushel, 2010).

Research on the global environment indicates that changes to water and land resources, and climate may have negative effects on food systems across the globe, which could increase food insecurity (Ingram, Ericksen, & Liverman, 2010; Murray, 2013; Tacoli, Bukhari, & Fisher, 2013). While developing areas of the world are more vulnerable to effects of global environmental changes, food systems in developed areas, including the U.S. are likely to be impacted as well (Lake et al., 2012). This has prompted research on adaptations to the current U.S. food system, including adopting the concept of more fully developed regional food systems to achieve regional food security.

Regional food security is the condition in which a region’s food needs are met through an optimal regional food system. Regional food systems are just one stratum in a

² Based on the definition employed by federal agencies, the Northeast region includes (from north to south): Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia and the District of Columbia (Environmental Protection Agency, 2015; Northeast Regional Climate Center, 2015; United States Department of Agriculture, 2015).

much larger nested food system that includes international, national and local systems. What differentiates a regional food system is the emphasis on regionally-based food production, processing and distribution, thereby increasing self-reliance and community food security by through resilience to global environmental changes (Clancy & Ruhf, 2010). Compared with local food systems, regional systems offer a much larger agricultural land base, greater diversity in food production, the possibility for more efficient food distribution and the possibility for improved public and private sector governance of food system issues (Lengnick, Miller, & Marten, 2015; Liverman & Ingram, 2010; Ruhf, 2015). Regional food security is the condition in which a region's food needs are met through an optimal regional food system.

The purpose of this research was to characterize the Northeast region from two distinct dimensions in order to begin the process of understanding its food needs and the potential for a regional food system to help meet them. First, the sociodemographic characteristics of the region were reviewed. The food security and nutrition literature suggests that sociodemographic characteristics have a significant role in influencing diet through food purchasing and consumption behaviors (Beydoun & Wang, 2008; Bower, Thorpe, Rohde, & Gaskin, 2014; Coleman-Jensen et al., 2014; Handbury, Rohkovsky, & Schnell, 2015; Ricciuto, Tarasuk, & Yatchew, 2006; Yoo et al., 2005). This research builds on the extant literature by reviewing these characteristics within at a regional scale. Second, food production characteristics of the region were reviewed. Understanding regional production is a critical step in the process of achieving regional food security (Clancy & Ruhf, 2010). The following review attempted to answer the following questions:

1. What are the sociodemographic characteristics of the Northeast region?
2. What are the food production characteristics of the Northeast?
3. To what extent does food production meet consumption in the region?

METHODS

Data Sources

Several publicly available data sets were used to explore sociodemographic and food production characteristics in the Northeast. Sociodemographic data were obtained from the American Community Survey unless noted otherwise. Five-year estimates were used because they provided a larger sample size and greater reliability than one and three-year estimates. Whenever possible, data from the year 2012 were used to provide consistency with data in Chapters 4 and 5. In cases where 2012 data were not available, data from the closest available year were used.

National and Regional Sociodemographic Data

Population size, sex, age, race, ethnicity and educational attainment data were obtained from the Social Characteristics Profile of the 2012 ACS (United States Census Bureau, 2012b). Median household income and the percentage of people living below poverty came from the Economic Characteristics Profile of the 2012 ACS (United States

Census Bureau, 2012a). Unemployment data were obtained from the Bureau of Labor Statistics from June 2012 (Bureau of Labor Statistics, 2012). Household composition data were obtained from the 2012 ACS Housing Characteristics Profile (United States Census Bureau, 2012c).

Urbanicity and population density data were obtained from the 2010 Decennial Census because these data are not collected in the ACS (United States Census Bureau, 2010b). The U.S. Census Bureau defines urban areas as areas with at least 50,000 people and rural areas are defined as areas with less than 50,000 people (United States Census Bureau, 2010a). Retail food environment data were obtained from the 2012 U.S. Census Bureau County Business Patterns (United States Census Bureau, 2012d). Data for supermarkets and grocery stores, convenience stores, meat markets, fish and seafood markets and fruit and vegetable markets were gathered by North American Industry Classification codes. Farmers' market data came from the 2016 USDA Farmers Market Directory, which was the only year available (United States Department of Agriculture, 2016a).

Data on households receiving SNAP were obtained from the Economic Characteristics Profile of the 2012 ACS (United States Census Bureau, 2012a). Data on the number of women participating in WIC came from USDA's Food and Nutrition Service 2012 WIC program data (United States Department of Agriculture, 2012b). Data on the number of students participating in the National School Lunch Program (NSLP) and School Breakfast Program (SBP) were obtained from the USDA's Food and Nutrition Service 2012 child nutrition data (United States Department of Agriculture, 2012a).

Land Use, Agricultural Production and Regional Self-Reliance

Regional land use, agricultural production and regional self-reliance data were retrieved from two sources. Land use data were from USDA Economic Research Service land use database, which was last collected 2007. Agricultural production figures and regional self-reliance data were obtained by research from Timothy Griffin at Tufts University (T. Griffin, personal communication, January 12, 2017). Regional self-reliance was computed using consumption and production data. Griffin and colleagues obtained agricultural production information for all crops and major livestock in the Northeast region from 2001 to 2010 (Griffin, Conrad, Peters, Ridberg, & Tyler, 2014). Sources for agricultural production data included USDA National Agricultural Statistics Service (NASS) Surveys, USDA NASS Agricultural Censuses, State Departments of Agriculture annual reports and State Departments of Agriculture specialty crop reports, research trials at land grant universities, regional yield data and personal communication with experts (Griffin et al., 2014). Consumption data were obtained from the Food Availability Data System at the USDA Economic Research Service. Estimates were acquired by, “subtracting annual exports from the annual sum of beginning stocks, domestic production and imports of individual commodities, and dividing the resultant by the national population” (Griffin et al., 2014, p. 352). This annual per capita figure was then multiplied by the population per year in the Northeast to achieve regional consumption. The regional self-reliance measure is a net balance and does not track flows

of food from production to consumption.

Analysis

Exploratory analyses were conducted using sociodemographic data at the national and regional levels. Sociodemographics are presented in percentages, medians and means. Data used to represent national statistics were available at the national level and did not require aggregation from state-level data. Data representing the Northeast region included each of the 12 Northeast states and the District of Columbia and were generated by aggregating state-level data.

When raw data were not available at the state level, regional-level data were calculated using weights. Median age could not be aggregated for the region from state-level data. Therefore, median age for the Northeast was calculated using weights that reflect the proportion of total regional population for each state. Average household size for the region was calculated using a weighted average to account for variations in the number of households in each state. The density of retail food establishments was measured by calculating the number of retail establishments per 10,000 people. The percentage of women participating in WIC was calculated by dividing the number of women participating in WIC by the total number of women in the nation and region, respectively. Data for NSLP and SBP were divided by total school enrollment data for 2012 obtained from the National Center Educational Statistics to calculate the percentage of students participating in the programs (National Center for Educational Statistics, 2012).

Land use data was aggregated from the state level to the regional level. Regional self-reliance measures were calculated for foods in the 12 categories and sub-categories from the USDA *What We Eat in America* from the National Health and Nutrition Examination Survey (United States Department of Agriculture, 2016b). Raw data were used to calculate regional self-reliance figures for milk and dairy, meats, poultry, seafood, eggs, cured meats and non-meat proteins. Findings for grains, fruit and vegetables were drawn from the parent study because a substantial amount of data for these items could not be re-categorized (Griffin et al., 2014). Data for snacks and sweets and mixed dishes categories could not be used due to significant processing. Production and consumption data for the USDA categories are presented in pounds. Regional self-reliance is estimated as the proportion of regional consumption that is satisfied by regional production and is presented as a percentage or:

$$\text{Total Regional Production} / \text{Total Regional Consumption} \times 100$$

RESULTS

Findings for this review are structured using the Ecological Systems Theory (EST) as a template. This allows for application of characteristics in specific levels of influence that can promote or inhibit patterned behaviors (Bronfenbrenner, 1977; McLeroy, Bibeau, Steckler, & Glanz, 1988). The following levels of influence are provided below: intrapersonal, interpersonal, community, public policy and

environmental levels. Results are discussed and presented in tables. Tables detailing state-level findings for sociodemographic figures are presented in Appendix A.

Intrapersonal

Interpersonal sociodemographic characteristics are presented in Table 3.1. As of 2012, approximately 21% of the U.S. population resided in the Northeast. The Northeast's largest states by population were New York and Pennsylvania, together accounted for roughly 20% of the region's population (Appendix A.1). Compared to the U.S. as a whole, the Northeast had a higher proportion of women as part of the population. All but three states (New Hampshire, Vermont and West Virginia) had higher a proportion of females than the national average (Appendix A.1). The Northeast had a higher median age than the U.S. as well; only the District of Columbia had a younger median age than the nation as a whole (Appendix A.1). When examining age more closely, the Northeast had higher proportions of 18 to 64 year olds and residents 65 years old and over. The District of Columbia had the highest proportion of 18 to 64 year olds, with more than 71% of its population in that age range. West Virginia and Maine had the highest proportions of 65 year old and over residents with approximately 16% of their residents falling within that range (Appendix A.1). The Northeast region also had a higher educational attainment compared with the U.S. as a whole. The region had a higher rate of high school graduates, college graduates and those with graduate or professional degrees. However, there is significant variation within states, with the

District of Columbia and Massachusetts had the greatest proportions of college graduates and West Virginia having the lowest (Appendix A.2).

The Northeast ranked higher on many economic indicators compared with the U.S. as a whole in 2012. The Northeast had a median household income more than \$7,000 greater than the national level. Furthermore, the region had lower percentages of residents below poverty. However, the percentage of members of the labor force that were unemployed was similar at the regional and national level in 2012. Maryland had the highest median household income (\$72,999) and West Virginia had the lowest (\$40,400) (Appendix 3.1).

Race and ethnicity figures varied between state, regional and national levels. Compared with national percentages, the Northeast had lower percentages of Hispanic and White residents, and a higher percentage of Black and Asian residents. However, while data show that the Northeast is more diverse on some indicators (with the exception of Hispanic residents and residents identifying as two or more races), much of these differences appear to be as a result of the Mid-Atlantic States of the Northeast. The New England States of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont have significantly higher percentages of White residents than the Mid-Atlantic States and the nation as a whole. The exception to that pattern is West Virginia, which has a population of approximately 94% White residents (Appendix A.4).

Interpersonal

Interpersonal characteristics are presented in Table 3.2. Household composition appears to be similar between the Northeast and the nation as a whole. Both the region and nation had an average household size of 2.61 persons per household in 2012. At the regional and national level, the percentages of households with children under the age of 18 are similar at 28.8% and 29.9%, respectively. The District of Columbia is an outlier on the percentage of households with children under the age of 18 at 17.3% (Appendix A.5).

Community

Community characteristics are presented in Table 3.3. The Northeast region accounts for approximately 6% of the total land area of the U.S. However, a much larger portion of the region is urban area (11%) than the nation as a whole (3%). The Northeast also had a larger percentage of its population living in urban areas. There are wide variations in urban population across the region (Appendix A.6). The density of supermarkets and grocery stores was greater in the Northeast (3.2 establishments per 10,000 people) than the U.S. (2.1 establishments per 10,000 people). However, the density of convenience stores, meat markets, fish and seafood markets, fruit and vegetable markets and farmers' markets did not differ at the regional and national levels. New York had the highest density of supermarkets but states were relatively consistent for other types of stores (Appendix A.7). The Northeast did have approximately 6% more of its farmers' markets accepting SNAP than the U.S. as a whole.

Public Policy

Table 3.4 presents participation rates in federal food programs. The rate of participation in federal food programs in the Northeast and U.S. appears to differ by program. While participation in SNAP ranges from a high of 15.8% in Maine and a low of 6.8% in New Jersey, the overall regional participation rate of 11.1% and the national rate of 11.4% are similar (Appendix A.8). Participation of women in WIC does not differ as widely as SNAP within the region with New Hampshire having a participation rate of 0.6% and both the District of Columbia and New York having 1.3% (Appendix A.8). Like SNAP participation, WIC participation is also similar at the regional and national level, 1.0% and 1.3%, respectively (Table 3.4). Participation rates in NSLP and SBP had wide ranges within the region from a low of 15.8% for NSLP in Connecticut and a high of 74.2% for SBP in Delaware (Appendix A.8). However, for both programs the U.S. participation rate was higher than the regional rate.

Environmental

The Northeast is made up of approximately 126 million acres of land, of which 61% was comprised of forested land. Approximately 16% of the land (cropland, grassland and range land) in the Northeast was devoted to agricultural purposes in 2007 (United States Department of Agriculture, 2007). Land in agriculture was highest for

Delaware (36%), Pennsylvania (22%) and New York (22%) (United States Department of Agriculture, 2007). The Northeast had the lowest percentage of land in agriculture when compared with other regions of the U.S. (United States Department of Agriculture, 2007).

Figure 3.1 presents land use for agricultural land used for the food supply in the Northeast. Of the land that is used in agriculture, more than half (56%) is used for livestock. This land is either used for growing animal feed crops, pasturing, grazing or foraging (Griffin et al., 2014). Another 36% is not in production because it is woodland that is not used for pasture, is used to grow non-food crops (tobacco, floriculture, etc.), or is agricultural land used for other purposes (barns, houses, roads, etc.) (Griffin et al., 2014). Figure 3.1 demonstrates that only 8% of agricultural land in the Northeast is used for growing food crops. Of that, the largest portion (3%) is used for grains, 2% is devoted to both vegetables and oils and only 1% is for fruit (Griffin et al., 2014). Table 3.5 shows the total production, consumption and regional self-reliance measure for each of the 12 USDA categories. Milk and dairy products had the highest regional self-reliance (76%), followed by eggs (72%) and seafood (45%). The lowest measures of regional self-reliance were exhibited in the non-meat protein (0%) and grains (8%).

DISCUSSION

Principal Findings

Findings demonstrate that residents of the Northeast region differed in several sociodemographic characteristics from the nation as a whole. Sociodemographic characteristics have been shown to impact dietary characteristics. Findings also indicate that while the Northeast has a large population and is more urban than the nation as a whole, it does include a significant amount of land that can be used for food production. However, more than a half of the agricultural land was used for food animal production and more than third was unused. Additionally, this research provides insight into the extent to which the Northeast is regionally self-reliant for specific food categories.

Implications

Residents of the Northeast are older and are more likely to be female, compared with the U.S. population. Research by Beydoun and Wang (2008) found that fruit and vegetable consumption was significantly higher if individuals were younger and if they were female. Their results also show that older and female individuals scored higher on indices of overall diet quality (Beydoun & Wang, 2008). These factors may effect dietary characteristics at the regional level as well. The racial composition of the Northeast appeared to be similar to the U.S., overall. However, the region did have a lower proportion of Hispanic residents than the U.S. In two studies of food purchasing,

Hispanic participants were more likely to purchase fruits and vegetables than non-Hispanic participants (Calloway et al., 2016; Cullen et al., 2007).

Northeast residents were more likely to have a higher education, greater income and less likely to be in poverty than the nation. Significant literature points to the role of income in predicting healthier dietary characteristics (Beydoun & Wang, 2008; Chung & Myers, 1999; Hendrickson, Smith, & Eikenberry, 2006; Stewart, Blisard, & Joliffe, 2003). However, this relationship has also shown to be moderated by education (Handbury et al., 2015).

Household factors appeared to be generally consistent between the U.S. and the Northeast. However, the Northeast had a greater proportion of its residents living in urban areas and the Northeast had a greater density of supermarket and farmers' markets. Purchasing and consumption are moderated by the availability and accessibility of food stores, which has been demonstrated in both urban and rural areas (Bitto, Morton, Oakland, & Sand, 2003; Champagne et al., 2007; Morton & Blanchard, 2007).

Participation in federal food assistance programs was lower in the Northeast than the nation overall. This is not surprising considering that the region has a higher median income than the U.S as a whole. However, differences in SNAP and WIC participation were only marginal lower than the nation. SNAP participants have been found to exhibit different dietary characteristics than others (Leung et al., 2012).

Land use information demonstrates that most of the land in the Northeast is forest cover. Of the agricultural land in the region, most of it is used for animal agriculture, either raising livestock or producing livestock feed. A substantial portion of agricultural land is not being used. Ruhf attributes the increase in forest cover and overall decline in

agriculture in the region to the migration of farmers in the late 19th century to more fertile soil in the Midwest (Ruhf, 2015). The data reflect that a small proportion of agricultural land in the Northeast is used for food crops like fruits and vegetables.

Finally, regional self-reliance findings indicated that there was a large variation in the extent to which regional consumption for food categories is satisfied by regional production. Only three categories, milk and dairy, eggs, and vegetables had regional self-reliance greater than 50%. However, the data used in self-reliance measures represent overall consumption in the region and therefore, do not account for important differences in dietary characteristics by sociodemographic factors at the regional level. Future research could help to reveal these differences.

Strengths and Weaknesses

This research attempted to describe specific aspect of the Northeast using both sociodemographic and agricultural data. Five-year estimates were used, when possible, to provide the most reliable sample of Northeast residents. Five-year estimates provide a larger sample size and include data for all areas, whereas one and three-year estimates only provide data in areas with 65,000 or more residents. To maintain consistency with Chapters 4 and 5, data from 2012 was used whenever possible. However, using five-year estimates also means that findings may not represent the most recent data collection.

Land use data were from 2007 since these were the most current data available. Agricultural production and consumption data were from 2001 to 2010. The data used here provides measures of production and consumption at the regional level, which is

informative. However, these measures do not capture variations in production and consumption across the region that may be important understanding the region's food needs.

CONCLUSIONS

This review attempted to characterize two dimensions of the Northeast to begin the process of understanding the region's food needs to improve regional food security. Sociodemographic factors were summarized because they have shown to have significant relationships with dietary characteristics. Results indicated that the sociodemographic characteristics of the Northeast region differed from those of the nation overall. This suggests that dietary characteristics of the region will be unique from the U.S. as a whole and that there is likely to be variations in dietary characteristics across the region as well. Future research is needed to gain further understanding of these dietary characteristics at the regional level. Research on sociodemographic factors and dietary characteristics is also needed to better distinguish their relationship in the Northeast.

Environmental factors were also assessed to gain a greater understanding of the opportunities for a future regional food system. Land use data demonstrated that a comparatively small portion of the land in the Northeast was used for agriculture and that most of this land was used for food animal production or was not in production at all. Regional self-reliance measures showed wide variations in self-reliance across several food categories. However, these data are limited because they measure homogeneous

consumption at the regional level. Further research is needed that explores specific dietary characteristics, the potential variation in these characteristics among residents in the Northeast, and their relationship with regional food security.

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Table 3.1 Comparison of Intrapersonal Level Characteristics between the United States and the Northeast Region

	United States	Northeast ^a
Total population	309,138,711 ^a	64,490,804 ^a
Sex		
Female	50.8% ^a	51.4% ^a
Median age	37.2 ^a	39.0 ^{a*}
Age Categories		
18-64	62.9% ^a	63.7% ^a
65 and Older	13.2% ^a	14.1% ^a
Race		
White	74.2% ^a	73.7% ^a
Black	12.6% ^a	14.2% ^a
Asian	4.8% ^a	5.4% ^a
Other	8.4% ^a	6.7% ^a
Hispanic	16.4% ^a	11.8% ^a
Education		
Less than high school	14.3% ^a	12.7% ^a
High school graduate	28.2% ^a	28.2% ^a
Some college	21.3% ^a	16.8% ^a
College graduate	36.2% ^a	40.2% ^a
Median Household Income	\$53,046 ^b	\$60,779 ^b
Poverty Status		
Below poverty	14.9% ^b	12.5% ^b
Employment Status		
Unemployed	8.0% ^c	8.2% ^c

Note: * Weighted average

^a (United States Census Bureau, 2012b)

^b (United States Census Bureau, 2012a)

^c (Bureau of Labor Statistics, 2012)

Table 3.2 Comparison of Interpersonal Level Characteristics between the United States and the Northeast Region

	United States ^a	Northeast ^a
Mean household size	2.6	2.6 *
Households with children under 18	29.9%	28.8%

Note: * Weighted average

^a (United States Census Bureau, 2012c)

Table 3.3 Comparison of Community Level Characteristics in the Northeast United States

	United States	Northeast
% Urban area	3.0% ^a	10.7% ^a
% Population Urban	80.7% ^a	84.3% ^a
<i><u>Density</u></i> <i><u>(per 10,000 people)</u></i>		
Supermarkets and grocery stores	2.1 ^b	3.2 ^b
Convenience stores	0.8 ^b	1.1 ^b
Meat markets	0.2 ^b	0.3 ^b
Fish and seafood markets	0.1 ^b	0.1 ^b
Fruit and vegetable markets	0.1 ^b	0.0 ^b
Farmers' markets	0.3 ^b	0.4 ^b
% Farmers' markets accepting SNAP	31.6 ^c	37.2 ^c

^a (United States Census Bureau, 2010b)

^b (United States Census Bureau, 2012d)

^c (United States Department of Agriculture, 2016a)

Table 3.4 Comparison of Public Policy Level Characteristics in the Northeast United States

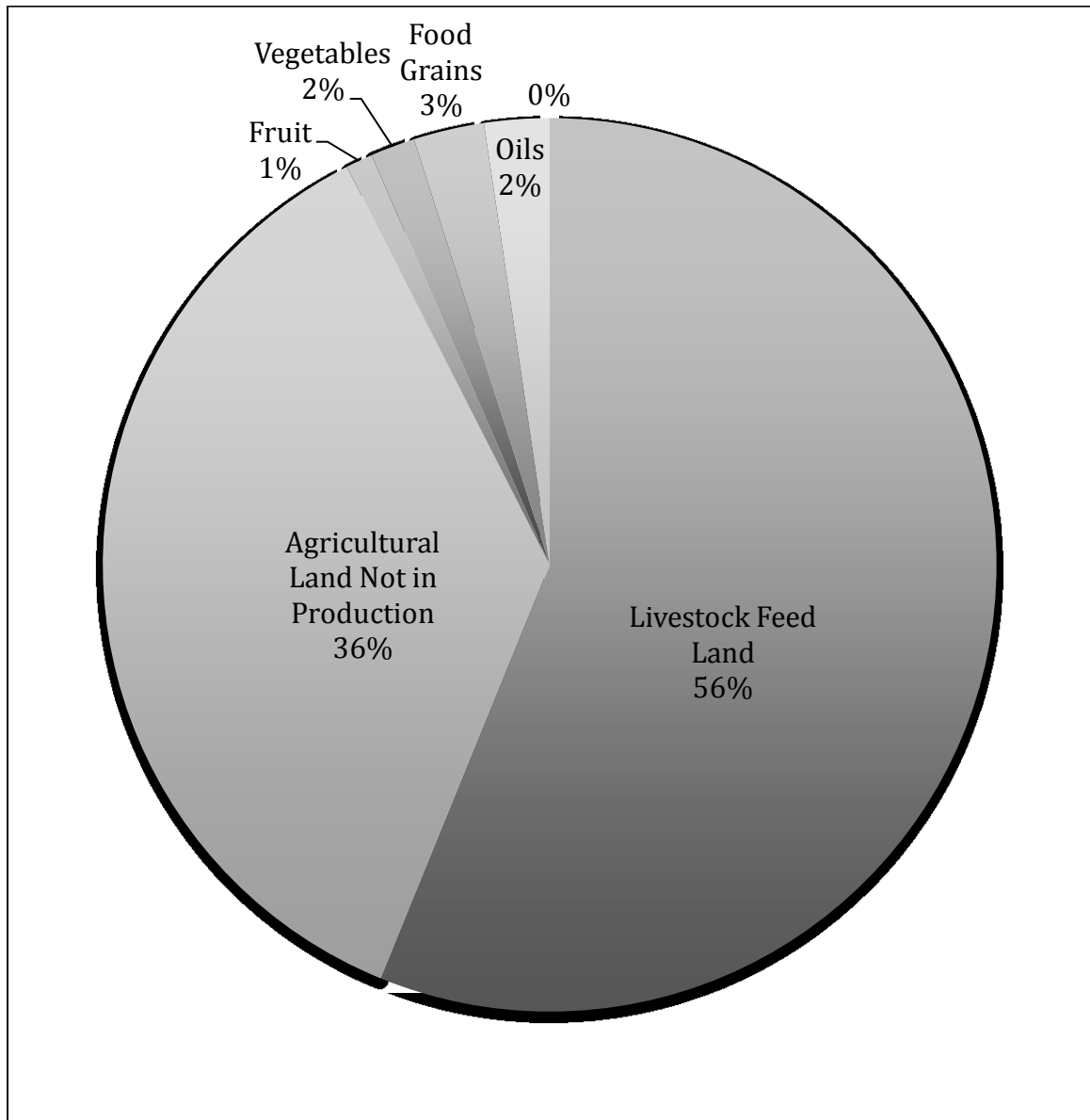
	United States	Northeast
Households receiving SNAP	11.4 ^a	11.1 ^a
Women receiving WIC	1.3 ^b	1.0 ^b
Students in NSLP	25.9 ^c	21.0 ^c
Students in SBP	63.8 ^c	60.7 ^c

^a Census (United States Census Bureau, 2012a)

^b (United States Department of Agriculture, 2012b)

^c (United States Department of Agriculture, 2012a)

Figure 3.1 Use of Agricultural Land Contributing to the Food Supply in the Northeast ^a



^a (Griffin et al., 2014)

Table 3.5 Total Production, Total Consumption and Regional Self-Reliance by USDA Category

USDA Category ^a	Total Production (lbs.) ^b	Total Consumption (lbs.) ^b	Regional Self-Reliance _b
<i>Milk and Dairy</i>	28,607,980,000	37,460,282,414	76%
<i>Meats</i>	1,554,920,057	6,840,471,910	23%
<i>Poultry</i>	1,477,609,680	3,650,603,518	41%
<i>Seafood</i>	443,890,237	1,002,792,882	45%
<i>Eggs</i>	1,465,045,500	2,043,869,922	72%
<i>Cured Meats</i>	2,673,648,453	8,861,591,850	31%
<i>Non-Meat Proteins</i>	33,620,567	15,752,762,599	0%
<i>Grains</i>	2,546,994,273	31,627,561,267	8%
<i>Fruit</i>	3,015,550,884	16,292,839,142	19%
<i>Vegetables</i>	5,670,565,524	20,396,880,858	28%
<i>Snacks and Sweets</i>	--	--	--
<i>Mixed Dishes</i>	--	--	--

^a (United States Department of Agriculture, 2016b)

^b (T. Griffin, personal communication, January 12, 2017)

CHAPTER 4

MANUSCRIPT 2:

DIETARY CHARACTERISTICS IN THE NORTHEAST UNITED STATES:

FOOD PURCHASES AND SOCIODEMOGRAPHIC CHARACTERISTICS

ABSTRACT

Introduction

Changes to the global environment could increase food insecurity in the Northeast United States by damaging existing food systems. Developing more robust regional food systems could be one approach to providing regional food security in light of environmental changes. However, little is known about the dietary characteristics of the Northeast region.

Objective

This study assessed the dietary characteristics of the Northeast region and explored the relationship between those characteristics and sociodemographic factors.

Methods

Data from the Bureau of Labor Statistics Consumer Expenditure Diary Survey were used to measure food purchasing in 12 food categories as indicators of dietary characteristics. Several multiple logistic regression models were used to analyze the relationship between sociodemographic factors and purchasing of food categories.

Results

Findings indicated that grains and milk and dairy were the most commonly purchased food categories. Findings also demonstrated having children less than 18 years of age, the

interaction between household income and education, ethnicity and race were consistently associated with dietary characteristics at a regional scale.

Conclusions

This research assessed dietary characteristics and their associations with sociodemographics at the regional level. Findings provide insight into the social determinants of diet within the region and could suggest differences in regional food security. Future research is needed to further explore dietary outcomes in the Northeast within a regional food systems context.

INTRODUCTION

Despite progress in food production, processing and distribution, accessibility and availability to adequate food remains a problem in the United States. According to the United States of Department of Agriculture definition of food security, “access by all people at all times to enough food for an active, healthy life”, 14.3% of America households were food insecure as of 2013 (Coleman-Jensen, Gregory, & Singh, 2014, p. 2). In the Northeast region of the U.S.³, food insecurity has increased faster than the nation as a whole since 2003 (Coleman-Jensen et al., 2014). Food insecurity is associated with a higher risk of diet-related diseases in individuals, making it a significant risk factor of morbidity and mortality (Seligman, Laraia, & Kushel, 2010).

Research on the global environment indicates that changes to water and land resources, and climate may have negative effects on food systems across the globe, which could increase food insecurity (Ingram, Ericksen, & Liverman, 2010; Murray, 2013; Tacoli, Bukhari, & Fisher, 2013). While developing areas of the world are more vulnerable to effects of global environmental changes, food systems in developed areas, including the U.S. are likely to be impacted too (Lake et al., 2012). This has prompted research on adaptations to the current U.S. food system, including adopting the concept of more fully developed regional food systems to achieve regional food security.

Regional food security is the condition in which a region’s food needs are met through an optimal regional food system. Regional food systems are just one stratum in a

³ Based on the definition employed by federal agencies, the Northeast region includes (from north to south): Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia and the District of Columbia (Environmental Protection Agency, 2015; Northeast Regional Climate Center, 2015; United States Department of Agriculture, 2015).

much larger nested food system that includes international, national and local systems. What differentiates a regional food system is the emphasis on regionally-based food production, processing and distribution, thereby relying less on importation, increasing self-reliance and improving community food security, while providing resilience to global environmental changes (Clancy & Ruhf, 2010). Compared with local food systems, regional systems may offer a much larger agricultural land base, greater diversity in food production, the potential for more efficient food distribution and the possibility for improved public and private sector governance of food system issues (Lengnick, Miller, & Marten, 2015; Liverman & Ingram, 2010; Ruhf, 2015).

The Northeast is an ideal setting for research on regional food systems because with approximately 65 million residents, food demand is high but current agricultural production is limited. Approximately 16% of the Northeast land base consists of agricultural land, of which 36% is not in use. The region also has plentiful water resources and several micro-climates that offer diverse agricultural products, producing more than 100 different food crops (Griffin, Conrad, Peters, Ridberg, & Tyler, 2014; Hance, Ruhf, & Hunt, 2006). The transportation infrastructure of the Northeast consists of well-developed highway, rail and sea transport systems that allow both rural and urban areas to be connected (Hance et al., 2006; Ruhf, 2015). There are several instances where regional governance mechanisms are already in place, with land and water resources frequently managed at the regional level (e.g., the Appalachian Region and the Chesapeake Bay watershed) (Appalachian Regional Commission, 2015; Chesapeake Bay Foundation, 2015). Despite the possible benefits of a more fully developed regional food

system in regard to food production, distribution and policy, little is understood about these systems from a demand-side perspective.

The purpose of this research was to explore dietary characteristics with the idea of eventually building a Northeast regional food system. Although there is substantial literature on food purchasing and consumption in the U.S., these studies focused on food security or nutrition as the outcome of interest. This research attempted to better understand dietary characteristics in the region by analyzing a broad selection of food purchasing data. The food security and nutrition literature indicate that sociodemographic factors have a significant role in influencing dietary characteristics (Beydoun & Wang, 2008; Bower, Thorpe, Rohde, & Gaskin, 2014; Coleman-Jensen et al., 2014; Handbury, Rohkovsky, & Schnell, 2015; Ricciuto, Tarasuk, & Yatchew, 2006; Yoo et al., 2005). This research attempted to build on those findings by exploring the role of sociodemographic factors in an exclusively regional sample of consumers. Through a quantitative approach, this research addressed the following questions:

1. What foods do households in the Northeast purchase?
2. What is the relationship between sociodemographic factors and dietary characteristics in the Northeast?

METHODS

Data Sources

Consumer Expenditure Survey Diary Survey

For this study, we used food purchasing as an indicator of dietary characteristics. Data were from the Bureau of Labor Statistics Consumer Expenditure Diary Survey for 2012 through 2014 (referred to as the Diary Survey from here on) (Bureau of Labor Statistics, 2016a). The Diary Survey is a continuously operating survey that collects data on U.S. households and their purchasing characteristics. The Diary Survey uses nationally and regionally representative probability samples of U.S. households composed to be representative of the civilian, non-institutionalized population (Bureau of Labor Statistics, 2016a). Participating households are recruited through the mail and data collection is conducted through face-to-face interviews and paper survey (Bureau of Labor Statistics, 2016b).

The Diary Survey includes two unique survey components; the Household Characteristics Questionnaire and the Expenditures Diary. The Household Characteristics Questionnaire is conducted as a face-to-face interview to collect information about sociodemographic characteristics for the primary respondent and all household members (Bureau of Labor Statistics, 2015). Primary survey respondents are considered to be the head of household (Bureau of Labor Statistics, 2016a). The Expenditures Diary is a paper form used to collect purchasing data for 104 items purchased over two consecutive one-

week periods (Bureau of Labor Statistics, 2013). The Expenditures Diary is used to collect expenditure data for frequently purchased items, including food for home consumption. The Household Characteristics Questionnaire and the Expenditures Diary can be matched through common ID numbers to generate a single dataset that includes sociodemographic characteristics and information on food purchased for home consumption.

Study Population

Data for this research were obtained by linking the Household Characteristics Questionnaire and the Expenditures Diary for every quarter in 2012, 2013 and 2014. Each quarterly dataset was checked for compatibility of variables and discrepancies were removed to establish consistency. Non-matched observations (n=7,402), non-Northeast states (n=506,543), observations with missing state identifiers (n=94,471), and observations with only one week of purchasing data (n=368) were removed. The final dataset included 3,428 household observations.

Analysis

Variable Definitions

The primary survey respondent reported the sociodemographic characteristics of themselves and their household. Select variables included: sex of the primary respondent

(coded as male=0 and female=1); age of the primary respondent (coded as the respondents age divided by five to represent five year intervals); race of the primary respondent (coded as White=1, Black=2, Asian=3 and Other=4); ethnicity of the primary respondent (coded as non-Hispanic=0 and Hispanic=1); education of the primary respondent (coded as less than a college education=0 and college education and above=1); household income (coded as the household income divided by 10,000 to represent \$10,000 intervals); children younger than 18 in the household (continuous); household members older than 64 (continuous); and household participation in SNAP in the last 12 months (coded as no=0 and yes=1).

Purchasing data on the 104 items from the Diary Survey's were categorized into 12 categories and sub-categories from the USDA *What We Eat in America* methodology used in the National Health and Nutrition Examination Survey national food survey (United States Department of Agriculture, 2016). Twenty-seven of the original Diary Survey items could not be categorized into the USDA categories and were, therefore, dropped (Appendix b.1). The 12 USDA categories were used as outcome variables. Each of the 12 outcomes were treated as a binary variable and were coded as a zero "0" if there were no purchases within that category over the two consecutive week sampling interval and a one "1" if there was a purchase within that category.

Statistical Analyses

Multivariate logistic regression analyses were conducted to estimate the associations between sociodemographic characteristics and the purchasing of the 12 food

categories. These analyses produced adjusted odds ratio (ORs), 95 percent confidence intervals (95% CI) and p-values. An alpha of 0.05 was used as a threshold for significance. The variables of sex, age, race, ethnicity, education, household income, children younger than 18, household members older than 64 and SNAP participation were included in the final models.

Several models were tested for each of the 12 outcomes before deciding on the final models. Several interaction terms using the final covariates were also created to measure effect modification. The interaction term for education and household income was the only interaction that showed consistent effect modification, so it was retained in the final model. Likelihood ratio tests also indicated that this interaction significantly improved model fit for seven of the 12 models. Covariates were also checked for collinearity. Household size was initially included in the models but was dropped because it was collinear with the number of children younger than 18 in the household ($r = .80$). All other covariates exhibited low variance inflation factors. All analyses were conducted using Stata Version 12 (StataCorp, 2011).

RESULTS

Sample Characteristics

Sociodemographic characteristics for the sample are presented in Table 4.1. The sample was majority female and the average age was 52. The sample was 80% White and

almost 48% had a college degree. The median household income was \$57,445, 31% of households had children under 18 years of age and 10% of households participated in SNAP in the last year.

Food Purchasing of USDA Categories

Exploratory analyses were conducted for purchasing characteristics using Diary Survey data. Purchasing characteristics are presented as percentages and mean expenditures in Table 4.2. Grains (92%) and milk and dairy (90%) were the most commonly purchased food categories, while non-meat proteins (40%) and seafood (43%) were the least commonly purchased. The mean amount spent on the 12 USDA categories on food for home consumption over the sampling interval was \$132. On average, households spent the largest percentage of their total spending on snacks and sweets, milk and dairy and vegetables.

The results from the multivariate logistic regression analyses for each of the 12 USDA categories are presented in Table 4.3 through Table 4.6. Table 4.7 presents a summary of the effects that selected covariates had on the outcome of purchasing for each of the categories. Compared with other covariates, the primary respondents' sex had less consistent effect on purchasing, increasing the likelihood among the fruits by 44% (95% CI=1.20;1.73; $p=.000$), vegetables by 37% (95% CI=1.12;1.68; $p=.002$), snacks and sweets by 34% (95% CI=1.10;1.16; $p=.003$), and mixed dishes by 15% (95% CI=1.00;1.32; $p=.048$). Similarly, primary respondents' age had a strictly positive effect on the purchasing of four groups. An increase of five years in age was associated with

12% increase in the likelihood of purchasing grains (95% CI=1.07;1.18; $p=.000$), a 9% increase in the likelihood of purchasing fruit (95% CI=1.05;1.13; $p=.000$), and a 4% increase in the likelihood of purchasing vegetables (95% CI=1.00;1.08; $p=.043$).

Identifying as Black or Asian had a largely negative effect on the purchasing of many of the food groups. Holding other sociodemographics constant, Black respondents were 59% less likely to purchase milk and dairy (95% CI=0.31;0.55; $p=.000$), 26% less likely to purchase cured meats (95% CI=0.60;0.92; $p=.007$), 38% less likely to purchase fruits (95% CI=0.48;0.79; $p=.000$), 37% less likely to purchase vegetables (95% CI=0.48;0.82; $p=.001$), 53% less likely to purchase snacks and sweets (95% CI=0.36;0.61; $p=.000$), and 44% less likely to purchase mixed dishes (95% CI=0.45;0.70; $p=.000$). Black respondents were 30% more likely to purchase poultry (95% CI=1.05;1.62; $p=.019$), Asian respondents were also 50% less likely to purchase milk and dairy (95% CI=0.33;0.77; $p=.002$), 47% less likely to purchase cured meats (95% CI=0.39;0.71; $p=.000$), 38% less likely to purchase grains (95% CI=0.40;0.97; $p=.000$), 50% less likely to purchase snacks and sweets (95% CI=0.34;0.72; $p=.000$) and 32% less likely to purchase mixed dishes (95% CI=0.51;0.92; $p=.011$). Asians were 108% more likely, however, to purchase seafood (95% CI=1.55;2.80 $p=.000$). The “other” race category did not exhibit significant associations with purchasing in any of the 12 USDA food groups.

Hispanic respondents were 46% more likely than non-Hispanics to purchase meats (95% CI=1.13;1.88; $p=.004$), 36% more likely to purchase poultry (95% CI=1.06;1.73; $p=.015$), 35% more likely to purchase seafood (95% CI=1.06;1.71; $p=.014$), 53% more likely to purchase eggs (95% CI=1.20;1.95; $p=.001$), 94% more

likely to purchase fruits (95% CI=1.40;2.69; $p=.000$) and 37% more likely to purchase non-meat proteins (95% CI=1.08;1.74; $p=.010$). Hispanic respondent were 27% less likely to purchase snacks and sweets (95% CI=0.54;1.00; $p=.048$) and 34% mixed dishes (95% CI=0.52;0.85; $p=.001$).

Having children was positively associated with the purchasing across all groups. The largest effects were seen in grains, snacks and sweets, mixed dishes and milk and dairy. Every additional child in the household was associated with a 92% increase in the likelihood of purchasing grains (95% CI=1.57;2.33; $p=.000$), a 43% increase in the likelihood of purchasing snacks and sweets (95% CI=1.26;1.62; $p=.000$), a 28% increase in the likelihood of purchasing mixed dishes (95% CI=1.18;1.38; $p=.000$), and a 28% increase in the likelihood of purchasing milk and dairy products (95% CI=1.11;1.47; $p=.001$).

Having adults over the age of 64 in the household also exhibited positive associations with purchase for seven of the 12 food groups, with the greatest effects in, vegetables, snacks and sweets, fruits, and eggs. Every senior in the household was associated a 34% increase in the likelihood of purchasing vegetables (95% CI=1.07;1.68; $p=.011$), a 33% increase in the likelihood of purchasing snacks and sweets (95% CI=1.07;1.65; $p=.010$), a 32% increase in the likelihood of purchasing fruits (95% CI=1.47;1.62; $p=.008$), and a 27% increase in the likelihood of purchasing eggs (95% CI=1.10;1.47; $p=.001$)

Participating in SNAP had very limited associations with purchasing. Only two of the food groups were associated with SNAP participation; a 35% decrease in likelihood of purchasing fruit (95% CI=0.48;0.87; $p=.004$) and a 33% decrease in likelihood of

purchasing snacks and sweets (95% CI=0.49;0.92; $p=.012$). The interaction between education and income was shown to have mixed associations with purchasing. Results reflect the likelihood in purchasing for every \$10,000 increase in income for college-educated respondents compared with \$10,000 increase in income for respondents without a college education. The results indicate that every \$10,000 increase among the college educated group was associated with a 7% decrease in the likelihood of purchasing milk and dairy (95% CI=0.88;0.99; $p=.013$); a 4% decrease in likelihood of purchasing meats (95% CI=0.94;0.99; $p=.011$), a 5% decrease in the likelihood of purchasing eggs (95% CI=0.93;0.98; $p=.000$), a 6% decrease in the likelihood of purchasing non-meat proteins (95% CI=0.92;0.97; $p=.000$), and a 7% decrease in the likelihood of purchasing snacks and sweets (95% CI=0.89;0.97; $p=.000$).

DISCUSSION

Principal Findings

This study provides a cross-sectional assessment of the relationships between the purchasing of several USDA food categories and sociodemographic factors among households in the Northeast region. The results revealed that several sociodemographic factors were consistently associated with purchasing across the food categories, including the presence of children in the household, the combination of education and income, race and ethnicity.

Implications

The findings presented here contribute to the body of literature on the complex relationships between dietary characteristics and sociodemographic factors. To our knowledge, this is the first study that examined these relationships at the regional scale, with a sample exclusively from the Northeast and with this many food categories. These findings showed that the characteristics most consistently associated with purchasing across all food categories were children less than 18 years of age, the interaction between household income and education, ethnicity and race. Of the 12 USDA categories that were used, respondents were more likely to purchase an item from all 12 categories for every additional child in the household.

Having children is a known predictor of food insecurity (Coleman-Jensen et al., 2014). However, the exact role that children have on household food purchasing is mixed. One study in the United Kingdom indicated that households with children are less likely to purchase fruit but more likely to purchase vegetables (Pollard, Greenwood, Kirk, & Cade, 2001). While other studies pointed to the role that children played in increase selectivity of food purchases, particularly in fruits and vegetables (Mushi-Brunt, Haire-Joshu, & Elliott, 2007; Reimer et al., 2004; Zachary, Palmer, Beckham, & Surkan, 2013). Our research did not provide insights into household food security but did indicate a tendency for households with children to purchase a larger variety of foods than those without. Programs and policies focused on changing food purchasing or consumption behaviors should account for the significant role that children play on the diet.

The effect of income on diet is widely reported but focuses predominantly on the availability and consumption of fruits and vegetables (Beydoun & Wang, 2008; Hendrickson, Smith, & Eikenberry, 2006; Inglis, Ball, & Crawford, 2009; Stewart, Blisard, & Joliffe, 2003). This research provides a much broader exploration of the role that income plays on dietary characteristics by measuring outcomes in a variety of food groups. Household income displayed associations with purchasing when combined with the primary respondent's educational attainment. This indicated that the effect of household income on the likelihood of purchasing for these categories modified by whether the respondent had attained a college degree. Milk and dairy, meats, eggs, cured meats, non-meat proteins, vegetables, and snacks and sweets, were all less likely to be purchased for every \$10,000 increase in household income when the respondent had a college education compared with when the respondent did not. Handbury et al. (2015) studied the combined effect of education and income and found that education played a much larger role in nutritional disparities than income. These results reinforce findings that income and education have a combined effect on diet.

Interestingly, respondents participating in SNAP showed no difference in the purchasing in 10 of the 12 categories compared with those not receiving SNAP. Results indicated negative associations with purchasing of both fruits and snacks and sweets. Overall this is contrary to results from a large study of National Health and Nutrition Examination Survey (NHANES) participants, which demonstrated that SNAP participants and non-participants, even with similar incomes, have different diets. Leung et al. (2012) found that SNAP participants were less likely to consume fruits and vegetables but more likely to consume red meat, snacks and sweets. Conflicting findings

may be due to the fact that the Diary Survey did not track the quantity of purchases, so the magnitude of purchases within each category was not measured. Furthermore, only 9.5% of the households in the sample were participating in SNAP, which could have restricted the effect size of the relationships.

Both race and ethnicity showed significant associations with purchasing, though the direction of these associations was less consistent than other sociodemographic factors. Black and Asian respondents were less likely to purchase milk and dairy, cured meats. Blacks were more likely to purchase poultry, while Asians were more likely to purchase seafood. Hispanic respondents were more likely to purchase both poultry and seafood, as well as meats, eggs, non-meat proteins and fruits. Black, Asian and Hispanic respondents were all less likely to purchase snacks and sweets and mixed dishes. These findings provide a more comprehensive assessment of the racial and ethnic antecedents of food purchasing than is typical in the nutrition or food security literature. In two studies of food purchasing, Hispanic participants were more likely to purchase fruits and vegetables than non-Hispanic participants (Calloway et al., 2016; Cullen et al., 2007). However, much of the literature is devoted to the significant differences in healthy food availability in areas with different racial compositions (Block & Kouba, 2007; Bower et al., 2014; Franco, Diez Roux, Glass, Caballero, & Brancati, 2008; Morland & Filomena, 2007). At the same time, the results here do not account for disparities in food availability, which may account for the differences. Even so, these findings could provide preliminary insights into the connections between race, ethnicity, culture and diet in the Northeast region.

Female respondents, age, and the number of household members over 64 also showed positive associations with purchases in a number of categories. Respondents in each of these categories were more likely to purchase fruits and vegetables and females and seniors were more likely to purchase snacks and sweets and mixed dishes. Being female and being older have been found to be significant predictors of healthier diets, which may account for increased likelihoods of purchases of fruits, vegetables and seafood (Ricciuto et al., 2006). However, the increased likelihoods of purchasing snacks and sweets and mixed dishes appear to contradict previous findings.

Strengths and Limitations

To date, no known published studies have investigated dietary characteristics from the perspective of a regional food system. Our study used a sample of Northeast households and provides a broad assessment of dietary characteristics at the regional scale. Additionally, this builds on previous research by investigating the relationships between significant sociodemographic factors and dietary characteristics.

The limitations of this research must also be examined. First, the Diary Survey measured food purchasing, which we used as a proxy for dietary characteristics. The survey also did not measure the magnitude with which respondents purchased foods. Furthermore, these data were unable to capture the availability and price of foods at the stores used by respondents. Therefore, we were unable to assess whether differences in purchasing were based on preferences or availability and access. Primary respondents may not have been the primary food shopper in the household, despite being the head of

household, so individual characteristics may not represent the person who actually purchased the food items. The USDA categories applied here focused on major food groups purchased for home consumption. Therefore, did not capture purchases of items like oils, condiments and beverages and did not capture purchases at restaurants, workplaces or other venues.

This research also used a repeated cross-sectional design, which does not allow for causality to be assessed between the outcome of purchasing and the independent variables. This could be a threat to internal validity, however most predictors were fixed and were not expected to have temporal ordering with the outcome of interest. Additionally, while the Bureau of Labor Statistics uses a probability sampling method intended to be regionally representative, their definition of the Northeast differed from ours. This means that these results may not be generalizable to the definition of the Northeast used in this research. However, we had limited options in using a publicly available dataset that measure food purchasing or food consumption that also provided state designators. Continued research on the demand-side characteristics within regional food systems must be conducted to collect a more representative sample within the Northeast.

CONCLUSIONS

This research was conducted to address a gap in knowledge regarding the dietary characteristics in the Northeast. Specifically, we wanted to assess difference in diet by

sociodemographic factors. Findings revealed the most commonly purchased food categories and the consistent sociodemographic characteristics that were associated with the purchasing of specific categories. Some of our findings support the existing literature, while other findings provide new information about the associations between sociodemographics and diet. We were able to assess these associations at a regional level, which provides insight into variations in diet across the Northeast, which may have implications for regional food security. Research is needed that further investigates distinct dietary patterns and more directly connects them to a future regional food system.

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Table 4.1 Sample Characteristics of the Bureau of Labor Statistics Diary Survey 2012 – 2014 (N=3,428) ^a

Characteristic	n	Statistics
Sex		
Female	1,931	56.3%
Median age		52.0
Age		
18-64	2,608	76.1%
65 and Older	820	23.9%
Race		
White	2,758	80.5%
Black	422	12.3%
Asian	207	6.0%
Other	41	1.2%
Hispanic	357	10.4%
Education		
Less than high school	349	10.2%
High school graduate	885	25.8%
Some college	561	16.4%
College graduate	1,633	47.6%
Median Household Income		\$57,445
Households with children under 18	1,070	31.2%
Households with persons over 64 years	1,002	29.2%
Households receiving SNAP	326	9.5%

^a (Bureau of Labor Statistics, 2016a)

Table 4.2 Purchasing Characteristics of USDA Categories (N=3,428) ^a

USDA Category	% of HHs purchasing category	Mean expenditures	% of total expenditures
Milk and dairy	89.9	\$14.93	12.7%
<i>Proteins</i>			
Meats	62.7	\$14.55	9.7%
Poultry	57.4	\$8.18	6.3%
Seafood	42.9	\$7.27	4.6%
Eggs	57.0	\$2.55	2.3%
Cured meats	62.4	\$8.41	6.0%
Non-meat proteins	40.2	\$3.11	2.2%
Grains	91.5	\$9.44	8.4%
Fruit	81.5	\$14.59	10.5%
Vegetables	86.3	\$16.98	12.4%
Snacks and sweets	84.9	\$18.36	14.3%
Mixed dishes	51.1	\$14.25	10.6%
Total Expenditures	--	\$132.63	100%

^a (Bureau of Labor Statistics, 2016a)

Table 4.3 Multivariate Analysis of Purchasing: Milk and Dairy, Meats and Poultry (N=3,428)

Covariate	<i>Milk and Dairy</i>			<i>Meats</i>			<i>Poultry</i>		
	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Sex									
Male	Ref.			Ref.			Ref.		
Female	0.98	0.77, 1.23	.840	1.05	0.91, 1.21	.517	1.09	0.94, 1.25	.252
Age (5 years)	1.02	0.98, 1.07	.305	1.03	1.00, 1.06	.060	1.00	0.98, 1.03	.797
Race									
White	Ref.			Ref.			Ref.		
Black	0.41	0.31, 0.55	.000	0.92	0.74, 1.15	.464	1.30	1.05, 1.62	.019
Asian	0.50	0.33, 0.77	.002	1.01	0.75, 1.37	.938	0.97	0.72, 1.31	.862
Other	1.01	0.35, 2.92	.981	1.27	0.65, 2.49	.484	0.85	0.45, 1.60	.616
Hispanic									
No	Ref.			Ref.			Ref.		
Yes	1.54	0.99, 2.39	.053	1.46	1.13, 1.88	.004	1.36	1.06, 1.73	.015
Education									
< College	Ref.			Ref.			Ref.		
≥ College	1.42	0.97, 2.07	.072	0.92	0.73, 1.16	.488	0.87	0.69, 1.09	.237
Income (\$10,000)	1.12	1.07, 1.18	.000	1.08	1.05, 1.10	.000	1.05	1.02, 1.07	.000
Children	1.28	1.11, 1.47	.001	1.22	1.12, 1.33	.000	1.26	1.16, 1.36	.000
Seniors	1.28	0.99, 1.65	.060	1.01	0.88, 1.17	.863	1.06	0.92, 1.23	.394
SNAP									
No	Ref.			Ref.			Ref.		
Yes	1.00	0.68, 1.47	.981	1.17	0.90, 1.52	.240	1.10	0.85, 1.42	.467
Education x Income	0.93	0.88, 0.99	.013	0.96	0.94, 0.99	.011	0.99	0.96, 1.01	.301

Note: *p* < .05 are in boldface

Table 4.4 Multivariate Analysis of Purchasing: Seafood, Eggs and Cured Meats
(N=3,428)

Covariate s	<i>Seafood</i>			<i>Eggs</i>			<i>Cured Meats</i>		
	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Sex Male Female	Ref. 1.14	.99, 1.31	.065	Ref. 0.94	0.82, 1.08	.371	Ref. 1.04	0.90, 1.19	.633
Age (5 years)	1.02	.99, 1.05	.128	1.01	0.98, 1.04	.398	1.02	0.99, 1.05	.163
Race White Black Asian Other	Ref. 1.22 2.08 1.07	.99, 1.52 1.55, 2.80 .57, 2.03	.065 .000 .829	Ref. 1.00 1.29 1.21	0.81, 1.24 0.96, 1.75 0.64, 2.29	.972 .093 .559	Ref. 0.74 0.53 0.68	0.60, 0.92 0.39, 0.71 0.37, 1.28	.007 .000 .236
Hispanic No Yes	Ref. 1.35	1.06, 1.71	.014	Ref. 1.53	1.20, 1.95	.001	Ref. 0.88	0.6, 1.12	.301
Education < College ≥ College	Ref. 1.23	.98, 1.54	.079	Ref. 1.37	1.09, 1.72	.007	Ref. 0.99	0.78, 1.25	.911
Income (\$10,000)	1.05	1.02, 1.07	.000	1.07	1.04, 1.09	.000	1.06	1.03, 1.08	.000
Children	1.09	1.02, 1.07	.021	1.22	1.13, 0.32	.000	1.20	1.10, 1.30	.000
Seniors	1.19	1.03, 1.37	.016	1.27	1.10, 1.47	.001	1.09	0.94, 1.27	.235
SNAP No Yes	Ref. 1.21	.94, 1.56	.130	Ref. 0.90	0.70, 1.16	.420	Ref. 1.06	0.82, 1.37	.658
Education x Income	0.98	.96, 1.01	.171	0.95	0.93, 0.98	.000	0.97	0.94, 1.00	.031

Note: *p* < .05 are in boldface

Table 4.5 Multivariate Analysis of Purchasing: Non-Meat Proteins, Grains and Fruit (N=3,428)

Covariates	Non-Meat Proteins			Grains			Fruit		
	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Sex									
Male	Ref.			Ref.			Ref.		
Female	1.08	0.93, 1.24	.306	0.92	0.71, 1.18	.489	1.44	1.20, 1.73	.000
Age (5 years)	1.04	1.01, 1.07	.010	1.12	1.07, 1.18	.000	1.09	1.05, 1.13	.000
Race									
White	Ref.			Ref.			Ref.		
Black	0.93	0.75, 1.17	.540	0.90	0.62, 1.30	.571	0.62	0.48, 0.79	.000
Asian	1.16	0.86, 1.57	.319	0.62	0.40, 0.97	.035	1.53	1.00, 2.35	.051
Other	1.32	0.70, 2.49	.390	1.19	0.36, 3.97	.778	2.19	0.83, 5.78	.115
Hispanic									
No	Ref.			Ref.			Ref.		
Yes	1.37	1.08, 1.74	.010	1.00	0.65, 1.53	.984	1.94	1.40, 2.69	.000
Education									
< College	Ref.			Ref.			Ref.		
≥ College	1.32	1.05, 1.67	.018	0.78	0.53, 1.17	.232	1.69	1.25, 2.30	.001
Income (\$10,000)	1.09	1.06, 1.11	.000	1.04	0.99, 1.08	.132	1.08	1.05, 1.12	.000
Children	1.16	1.07, 1.25	.000	1.92	1.57, 2.33	.000	1.25	1.13, 1.39	.000
Seniors	1.18	1.02, 1.36	.024	1.04	0.79, 1.35	.799	1.32	1.07, 1.62	.008
SNAP									
No	Ref.			Ref.			Ref.		
Yes	1.04	0.80, 1.35	.765	0.85	0.55, 1.33	.483	0.65	0.48, 0.87	.004
Education x Income	0.94	0.92, 0.97	.000	0.99	0.94, 1.04	.681	0.96	0.93, 1.00	.061

Note: *p* < .05 are in boldface

Table 4.6 Multivariate Analysis of Purchasing: Vegetables, Snacks and Mixed Dishes (N=3,428)

Covariates	<i>Vegetables</i>			<i>Snacks and Sweets</i>			<i>Mixed Dishes</i>		
	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Sex									
Male	Ref.			Ref.			Ref.		
Female	1.37	1.12, 1.68	.002	1.34	1.10, 1.63	.003	1.15	1.00, 1.32	.048
Age (5 years)	1.04	1.00, 1.08	.043	1.04	1.00, 1.08	.074	1.00	0.97, 1.03	.844
Race									
White	Ref.			Ref.			Ref.		
Black	0.63	0.48, 0.82	.001	0.47	0.36, 0.61	.000	0.56	0.45, 0.70	.000
Asian	1.53	0.92, 2.55	.102	0.50	0.34, 0.72	.000	0.68	0.51, 0.92	.011
Other	0.78	0.35, 1.73	.536	1.88	0.65, 5.41	.244	0.83	0.44, 1.56	.566
Hispanic									
No	Ref.			Ref.			Ref.		
Yes	1.04	0.75, 1.43	.829	0.73	0.54, 1.00	.048	0.66	0.52, 0.85	.001
Education									
< College	Ref.			Ref.			Ref.		
≥ College	1.99	1.41, 2.81	.000	1.90	1.38, 2.62	.000	1.05	0.83, 1.32	.687
Income (\$10,000)	1.09	1.05, 1.13	.000	1.08	1.04, 1.12	.000	1.05	1.03, 1.07	.000
Children	1.20	1.07, 1.35	.002	1.43	1.26, 1.62	.000	1.28	1.18, 1.38	.000
Seniors	1.34	1.07, 1.68	.011	1.33	1.07, 1.65	.010	1.25	1.09, 1.44	.002
SNAP									
No	Ref.			Ref.			Ref.		
Yes	1.15	0.82, 1.61	.427	0.67	0.49, 0.92	.012	1.04	0.80, 1.01	.779
Education x Income	0.96	0.92, 1.00	.040	0.93	0.89, 0.97	.000	0.98	0.96, 1.01	.154

Note: *p* < .05 are in boldface

Table 4.7 Associations Between Sociodemographic Factors and Food Purchasing for 12 USDA Categories

Socio-demographics	USDA Food Categories											
	<i>Milk and Dairy</i>	<i>Meats</i>	<i>Poultry</i>	<i>Seafood</i>	<i>Eggs</i>	<i>Cured Meats</i>	<i>Non-Meat Proteins</i>	<i>Grains</i>	<i>Fruits</i>	<i>Vegetables</i>	<i>Snacks and Sweets</i>	<i>Mixed Dishes</i>
Female									+	+	+	+
Age (5 years)							+	+	+	+		
Black	-		+			-			-	-	-	-
Asian	-			+		-		-			-	-
Other												
Hispanic		+	+	+	+		+		+		-	-
Children	+	+	+	+	+	+	+	+	+	+	+	+
Seniors				+	+		+		+	+	+	+
SNAP									-		-	
Education x Income	-	-			-	-	-			-	-	

Note:

+ Indicates covariate significantly increased likelihood of purchase

- Indicates covariate significantly decreased likelihood of purchase

CHAPTER 5

MANUSCRIPT 3:

IDENTIFYING DIETARY PATTERNS WITH A REGIONALLY SIGNIFICANT

MARKET BASKET IN THE NORTHEAST UNITED STATES

ABSTRACT

Introduction

Global environmental changes could have damaging effects on existing food systems and the availability of and accessibility to adequate food, thereby increasing in food insecurity in the Northeast United States. By developing more robust regional food systems, region food security could be improved. However, little is known about the food needs of the region, including specific dietary patterns.

Objective

This study aimed to identify dietary patterns using a market basket of regionally significant foods from the Northeast.

Methods

This study employed latent variable methods using data from customer intercept surveys from the USDA-funded Enhancing Food Security in the Northeast project. Purchasing of eight regionally significant items was assessed. Latent class analysis was used to identify distinct dietary patterns among the sample. Latent class regression was used to assess relationships among dietary patterns and sociodemographic factors.

Results

Findings demonstrated that there were four different dietary patterns among the sample: Buy All, Meat & Potatoes, Fresh Fruits & Vegetables, and Buy Nothing. Latent class

regression indicated that several sociodemographic factors were associated with the dietary patterns.

Conclusions

This research identified distinct dietary patterns exhibited by a sample of supermarket customers in the Northeast and investigated the sociodemographic factors that were related to these patterns. Purchasing of regionally-specific foods were assessed to interpret these patterns within a regional food security context. Future research on the role of diet in regional food security is necessary.

INTRODUCTION

Accessibility to adequate food is a significant problem in the United States. As of 2013, 14.3% of American households failed to meet the United States Department of Agriculture definition of food security, “access by all people at all times to enough food for an active, healthy life” (Coleman-Jensen, Gregory, & Singh, 2014, p. 2). In the Northeast U.S.⁴, food insecurity is increasing at a faster pace than the rest of the country (Coleman-Jensen et al., 2014). Food insecurity is an important public health concern because it is associated with a higher risk of diet-related diseases, and therefore, morbidity and mortality (Seligman, Laraia, & Kushel, 2010).

Research on global environmental changes suggests that water and land scarcity, and climate change may have negative effects on existing food systems, thereby, increasing food insecurity (Ingram, Ericksen, & Liverman, 2010; Murray, 2013; Tacoli, Bukhari, & Fisher, 2013). Though developing areas of the world are more vulnerable to effects of global environmental changes, food systems in developed areas, including the U.S. are likely to be altered (Lake et al., 2012). In the U.S., researchers are looking at adaptations to the current food system to provide resilience from global environmental changes. One area of research that has recently gained attention is the potential for regional food systems to provide regional food security.

Regional food security is the condition in which a region’s food needs are met through an optimal regional food system. Regional food systems are just one stratum in a

⁴ Based on the definition employed by federal agencies, the Northeast region includes (from north to south): Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia and the District of Columbia (Environmental Protection Agency, 2015; Northeast Regional Climate Center, 2015; United States Department of Agriculture, 2015c).

much larger nested food system that includes international, national and local systems. Regional food systems are unique in that they emphasize regionally-based food production, processing and distribution, thereby relying less on importation, increasing self-reliance and improving community food security, while providing resilience to global environmental changes (Clancy & Ruhf, 2010). Compared with local food systems, regional systems offer a much larger agricultural land base, greater diversity in food production, the possibility for more efficient food distribution and the possibility for improved public and private sector governance of food system issues (Lengnick, Miller, & Marten, 2015; Liverman & Ingram, 2010; Ruhf, 2015).

The Northeast presents a good opportunity to study the future regional food systems. With approximately 65 million residents food demand is high but agricultural land is limited. Approximately 16% of the Northeast land base consists of agricultural land, of which between 36% is not in use. The Northeast is home to several micro-climates that offer diverse agricultural products, producing more than 100 different food crops and offers ample water resources (Griffin, Conrad, Peters, Ridberg, & Tyler, 2014; Hance, Ruhf, & Hunt, 2006). The region also has a robust transportation infrastructure consisting of highway, rail and sea transport systems (Hance et al., 2006; Ruhf, 2015). Additionally, regional governance mechanisms are already in place, with land and water resources frequently managed at the regional level (e.g., the Appalachian Mountains and the Chesapeake Bay watershed) (Appalachian Regional Commission, 2015; Chesapeake Bay Foundation, 2015). The focus of most research on regional food systems is on production, distribution and policy, and little is understood about regional food systems from a demand-side perspective.

The purpose of this research was to identify dietary patterns using a market basket of regionally significant foods from the Northeast. In doing so, latent variable methods, including latent class analysis and latent class regression were used. To date, dietary patterns have primarily been a focus of the nutrition literature, which can overemphasize the purchasing and consumption of specific foods (e.g. fruits and vegetables). While this research has its merits, it does not adequately represent the whole diet. This research used latent class analysis to better understand the holistic patterns in which consumers purchase food significant to a regional food system. The nutrition literature also demonstrates that food purchasing and consumption differences often vary by sociodemographic factors (Beydoun & Wang, 2008; Bower, Thorpe, Rohde, & Gaskin, 2014; Coleman-Jensen et al., 2014; Handbury, Rohkovsky, & Schnell, 2015; Ricciuto, Tarasuk, & Yatchew, 2006; Yoo et al., 2005). We attempted to add to this literature by assessing the relationship between sociodemographic factors and dietary patterns using latent class regression. This research addressed the following questions:

1. Are there unique patterns in which market basket items are purchased?
2. What is the relationship between sociodemographic factors and these patterns?

METHODS

Study Design

The Enhancing Food Security in the Northeast (EFSNE) study was a USDA-funded multi-institutional research project, which aimed to better understand whether greater reliance on regionally produced foods can improve food access for low-income communities while also benefiting farmers, food supply chain firms, and others in the food system. From March 2011 through December 2015, project staff engaged in recruitment, data collection and analysis activities across multiple project initiatives, including the supply chain of production, distribution and consumption. The research and results presented here pertain to the consumption initiative, which focused on the demand-side characteristics of a regional food system.

Sampling and Recruitment

The population for this study were residents of the Northeast. Data collection took place at supermarkets throughout the region. Sampling of stores was conducted using a convenience sampling strategy and was based on previous relationships with and proximity to one of the participating EFSNE institutions. These criteria were considered necessary based on the intensive data collection process for the overall project. To be eligible the stores had to meet the definition of a supermarket and had to sell all of the EFSNE market basket foods. The Food Marketing Institute definition of a supermarket

(sells groceries, meat and produce and has at least \$2 million in annual sales) was used to determine eligibility (Food Marketing Institute, 2015). The convenience sample recruited a mix of stores in low and middle-income areas. The final study sample consisted of 15 supermarkets in nine study locations in six Northeast states. Customers were then sampled from each of the participating supermarkets (Appendix C.1).

The study aimed to recruit a sample of 100 customers from each supermarket in each of three rounds of data collection. A non-probability sampling strategy was used to recruit participants. Potential participants were actively recruited upon exiting the supermarket and were approached about answering question regarding their food purchasing habits and demographic information for a survey lasting five to seven minutes. Those who agreed to participate were screened for eligibility. In all three rounds of data collection eligibility criteria included being at least 18 years of age and being the primary food shopper in their household. For Round 1, eligibility criteria also included purchasing groceries at that supermarket that day and being a resident of the neighborhood surrounding the supermarket. Initially, the EFSNE team believed these criteria would restrict the sample to those who used the supermarket as their primary source of food. After Round 1, we learned that the supermarkets attracted customers from inside and outside the surrounding neighborhood. Therefore, these criteria were removed for Rounds 2 and 3.

To avoid a biased sample, recruitment occurred in mornings, afternoons and evenings and in nine of the 12 months. Recruitment was also conducted during both the monthly SNAP benefit cycle and outside of the cycle (e.g., in Maryland, during this time, SNAP benefits were distributed between the 6th and 15th of the month). Participants

determined eligible were provided with the purpose, procedures, benefits and voluntary nature of the research and were then asked to give verbal consent to participate. Oral consent was used instead of written consent in an effort to maintain anonymity. As compensation for their time, in Rounds 2 and 3, participants were provided with \$5 gift cards to the supermarket.

Data Collection and Instruments

From November 2012 through April 2015 EFSNE researchers conducted three rounds of data collection at the 15 supermarkets. Some of the study supermarkets did not participate in every round of the study due to attrition. Twelve supermarkets participated in Round 1 and 14 supermarkets participated in Rounds 2 and 3. Eleven supermarkets participated for all three rounds of data collection. In three instances a store was lost to attrition and replaced by a nearby store.

The customer survey consisted of 25 questions and was administered face-to-face immediately outside the supermarket. Survey items consisted of demographic and household characteristics, perceptions about their neighborhood's food environment and their purchasing of eight specific market basket foods (Appendix C.2). The customer survey had high face and content validity. The data collector read the questions and wrote responses on a paper copy of the survey. In total, 2,887 customer surveys were administered across all three rounds of data collection. Between Rounds 1 and 2 of data collection, the eligibility criteria and the wording of questions related to food purchases changed. Therefore, data from Rounds 2 and 3 are systematically different from those in

Round 1. For this reason only data from Rounds 2 and 3 were used for analysis and included 1,996 participants.

Selection of Market Basket Items

A market basket is a commonly used instrument designed to represent a total diet in nutrition and diet research, though their size and composition vary depending on the research objectives. The USDA-recommended Thrifty Food Plan, for instance, is a market basket used for the development of food and nutrition policy in the U.S. and is frequently used as the foundation for smaller market basket analyses in research in specific populations (Anderson et al., 2007; Jetter & Cassady, 2006; Neault, Cook, Morris, & Frank, 2005). Some studies have used market basket analyses to compare the availability of items in different communities, while others have designed them based on factors such as popularity, convenience, healthfulness and food contamination (Block & Kouba, 2007; Burns, Gibbon, Boak, Baudinette, & Dunbar, 2004; Norton et al., 2015; Short, Guthman, & Raskin, 2007).

This research employs the market basket created for the EFSNE project, which was designed to reflect foods significant to a Northeast regional food system. The research team selected staple items from every food group in the USDA Food Guidance System (fruits, vegetables, grains, protein and dairy) (United States Department of Agriculture, 2015b). A combination of fresh and processed items was selected because processing is critical to extending the growing season and increases profits for the supply chain. Finally, seeking to assess food purchasing in a regional food system context, the

team selected items based on their current and past (and therefore, future) capability to be produced in the Northeast region. EFSNE team members measured the regional self-reliance, the net balance between the regional production and regional consumption of the food, from 2001 to 2009. Regional self-reliance figures are presented as percentages and indicate the extent to which production can satisfy demand for each item (Griffin et al., 2014). The final market basket consisted of eight items: milk, ground beef, bread, apples, canned peaches, frozen broccoli, cabbage, and fresh potatoes. A brief rationale for each of the market basket items is provided below.

Milk

Fluid milk was selected due to its popularity as a staple dairy product. All states in the region had functional dairy farms as of 2013, and New York and Pennsylvania were among the top five milk producing states in the nation (United States Department of Agriculture, 2015a). The regional self-reliance for fluid milk was 76%.

Ground Beef

Ground beef constitutes 63% of the total food service beef and 49% of total retail beef volume in the U.S., making it a staple protein item (Speer, Brink, & McCully, 2015). Though the Northeast is not a top producer of beef cattle, the production of milk in New York and Pennsylvania contribute to ground beef production through the culling of dairy cattle. According to a report in 2009, approximately 18% of beef production comes from

culled dairy, most of which is used for ground beef (Lowe & Gereffi, 2009). The regional self-reliance for all beef was 16%.

Bread

Wheat is grown in the Northeast, but no state in the region was a top 10 producer from 2012 to 2014 (United States Department of Agriculture, 2015a). The EFSNE team assumed that the bread available in the project stores was made with wheat flour grown outside the region, but had been likely baked and distributed within the region. It was not possible to calculate the regional self-reliance for wheat or bread.

Apples

In 2014, the Northeast produced approximately 12% of the nation's fresh apples. New York and Pennsylvania were both in the top five of apple producing states (United States Department of Agriculture, 2015a). The regional self-reliance for fresh apples was 81%.

Canned Peaches

Peaches were selected because they are the most popular canned fruit consumed in the U.S. Peaches grown in the Northeast account for approximately 5% of the U.S.

processed peach production by volume (United States Department of Agriculture, 2015a). Regional self-reliance for fresh and processed peaches was 26%.

Frozen Broccoli

The majority of broccoli grown for the fresh market in U.S. is grown in California and Arizona; up to 98% depending on the season. However, it is also grown in five Northeast states where it accounts for approximately 11% of total production in the summer and fall (Atallah & Björkman, 2014). The regional self-reliance for broccoli was 1% and all of the frozen broccoli in the stores we studied was grown overseas.

Cabbage

Cabbage is the fourth highest value crop produced in the region. In 2013, New York was the second leading cabbage producer in the U.S., behind only California (United States Department of Agriculture, 2015a). The regional self-reliance for cabbage was 105%, which indicates that production was greater than consumption.

Fresh Potatoes

As of 2014, the Northeast accounted for approximately 9% of the nation's potato production. Maine accounted for approximately 65% of the potatoes produced in the

Northeast (United States Department of Agriculture, 2015a). The regional self-reliance for fresh potatoes was 38%.

Analysis

Variable Definitions

Variables were selected for data analysis based on their significance in the food security and nutrition literature. Participants were asked several questions about their sociodemographic and household characteristics. The following were open-ended questions: participants age (coded as continuous but divided by five to represent five year intervals); participants education in years (coded continuous) and number of children under five years of age for which they shop (continuous).

The stores' urban/rural designation was assessed using 2010 Census Bureau urban and rural designations (United States Census Bureau, 2010). The rural variable was indicated by a binary variable, coded as 0 for urban areas and 1 for rural areas. They were also asked to indicate their gender with a binary response, coded as 0 for male and 1 for female. Participation in public assistance was measured by asking if participants or anyone in their household participated in any of the following programs: SNAP, WIC, The National School Lunch or National School Breakfast programs, Supplemental Security Income and Head Start. Responses were recorded and coded 0 for no and 1 for yes. An interaction term was created to test for effect modification between education and public assistance participation, but it was not included in the final model because it did

was not statistically significant in any of the models. Finally, participants were asked if they purchased each of the eight market basket items in the past 30 days. Responses are scored as a binary, coded 0 for no and 1 for yes. The eight responses served as the outcomes for the analysis.

Statistical Analyses

The analyses for this research include two latent variable techniques: latent class analysis and latent class regression. Latent class analysis is an analytic method used to identify unobserved subgroups or classes from observed categorical responses. For this research, latent class analysis was conducted using the eight dependent binary variables in order to investigate the patterns in which they were purchased. First, models with two, three, four, five and six classes were fit. Based on model diagnostics, the model that best fit the data was selected. For model diagnostics with p-values, an alpha of 0.05 was used as a threshold for significance.

Parameter estimates were then used to interpret the meaning for each of the classes in the model. Latent class probabilities represent the probability that an individual is a member of a certain class. Using latent class probabilities the number of members in each class can be calculated. Conditional probabilities represent the probability that an individual purchased each of the eight market basket items, for each class. From conditional probabilities for each class, distinct patterns can be interpreted. Standard errors for conditional probabilities were used to assess the reliability of the parameter estimate.

Next, the selected model was used in latent class regression models in order to assess predictors of being a member in one class versus another class. These analyses produced odds ratio (ORs), 95 percent confidence intervals (95% CI) and p-values. An alpha of 0.05 was used as a threshold for significance. The variables of sex, age, education, store location and participation in public assistance were selected for use in the final regression model. The regression models were specified with 2000 starting values and the *Cluster* command was used to account for associations within the stores. Because of missing covariates, 155 observations were dropped from the final regression analyses. All analyses were conducted using Mplus Version 7 (Muthén & Muthén, 2015).

RESULTS

Sample Characteristics

Approximately 66% of participants were female, the median age was 48 years old and 85% of the sample was between 18 and 64 years old at the time of the survey (Table 5.1). The median years of education was 12 years and 60% of the sample had an educational attainment between 12 and 15 years, likely indicating that a majority of participants had a high school degree but less than a four-year college degree. The median household size was three people, and 24% of participants indicated that they usually shop for children younger than five years of age. Eighty percent of the surveys

were conducted in urban store locations, and 44% of the participants lived in households that participated in some form of public assistance.

Market Basket Purchasing Characteristics

The purchasing characteristics of the market basket items are presented in Figure 5.1. The mode of purchased items was four (15%) and the most infrequent number of purchased items was one item (7%). In total, 35% of the respondents purchased three items or fewer. Of the market basket items, bread was the most popular purchase (79%), followed by milk (72%), and potatoes (66%). The least popular market basket item was canned peaches, which 25% of participants purchased. The overall popularity of market basket items is not surprising, given that the EFSNE project team selected staple food items. However, the difference between the popularity between items like bread and milk, and canned peaches do indicate that demand for the market basket items varied.

Model Diagnostics

Several iterations of latent class analysis were conducted using two, three, four and five class models. The model fit statistics for each class are presented in Table 5.2. The chi-squared test (χ^2) and likelihood ratio test (LRT) provide fit statistics based on the comparison of the observed response pattern frequencies to the model's response pattern frequencies. Significant p-values indicate a statistically significant difference between the model and observed pattern frequencies and therefore, represent poor model fit (Geiser,

2013). These results from the chi-squared and likelihood ratio tests indicate that the best model is a four, five or six-class model.

The Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) are tests that take into account model fit and parsimony. Test statistics alone are not meaningful, but can be used to make model comparisons. For both AIC and BIC, models with lower information criteria are preferred (Geiser, 2013). The AIC indicates a six-class model has the best fit, while the BIC prefers a four-class model. The Lo Mendell Rubin (LMR) and bootstrap likelihood ratio test (BLRT) are relative fit statistics. They directly compare each model with a model with one fewer class (e.g., a five-class model versus a four-class model). Significant p-values in this case indicate the larger model fits the data better than the more parsimonious model. The LMR and BLRT statistics prefer two, three, four and five-class models.

Finally, entropy is a summary measure for the classification quality for each model in the latent class analysis. As values near one, they are indicators of good classification accuracy, while values closer to zero represent poor accuracy (Geiser, 2013). Entropy statistics indicate accurate classifications for two, three and four-class models. Based on the model fit statistics presented in Table 5.2, a four-class model was selected for the final model.

Parameter Estimates

The frequencies and percentages of market basket purchases, along with latent class probabilities, conditional probabilities and class interpretations for a four-class

model are presented in Table 5.3. The latent class probabilities indicate that 35.9% (n=661) of the sample were in Class 1, 22.9% (n=422) were in Class 2, 23.9% (n=440) and 17.3% (n=318) were in Class 4. Conditional probabilities are also presented and represent the probability that members in each of the classes indicated that they purchased the corresponding market basket item. Using the conditional probabilities, one can interpret the significance for each class. Class 1 shows comparatively high probabilities for all eight market basket items, which indicates that members of this class were more likely to purchase these items compared with the other classes. Therefore, Class 1 is being labeled the Buy All class.

Class 2 shows relatively high probabilities for milk, ground beef, bread and potatoes, yet low probabilities for apples, canned peaches, frozen broccoli and cabbage. Because of low probabilities purchasing fruits and vegetables, Class 2 can be designated as Meat & Potatoes. By comparison, Class 3 shows high probabilities for apples, cabbage and potatoes, though not as high as Class 1. The interpretation for Class 3, therefore, is Fresh Fruits & Vegetables. Finally, Class 4 shows the lowest probabilities across all market basket items. For that reason, Class 4 is being designated as the Buy Nothing class. Figure 5.2 presents the conditional probabilities for the four-class model and displays the differentiation between the classes.

Once classes were interpreted, a series of multivariate latent class regression analyses were conducted to investigate the relationship between sociodemographic characteristics and the probability of being in one class versus others. Class 1 was selected to be the comparison class because it was the largest of all the classes and the high probabilities across all items allowed for easy comparisons with the other classes.

Class 3 and Class 2 were also compared with each other to assess differences. Results from the regression analyses indicated that sex, age and participation in public assistance displayed the most consistent statistical significance in their relationships with class membership (Table 5.4). However, education and shopping for children younger than five years of age was also associated with being a member of some of the classes.

Female participants were 43% less likely to be in the Meat & Potatoes class versus compared with the Buy All class (95% CI=0.37;0.87; $p=.010$). Age was also related, with every five-year interval being associated with a 4% decrease in likelihood of being in the Meat & Potatoes class versus compared with the Buy All class (95% CI=0.95;0.97; $p=.000$). Education was associated with being in the Fresh Fruits & Vegetables class versus the Buy All class, with every additional year of education accounting for a 49% increase in likelihood of being in the Fresh Fruits & Vegetables class (95% CI=1.28;1.73; $p=.000$). However, shopping for children younger than five and participating in public assistance programs had opposite associations. Every additional child being shopped for was associated with a 31% decrease in likelihood of being in the Fresh Fruits & Vegetables class versus the Buy All class (95% CI=0.49;0.96; $p=.000$), and participating in public assistance was associated with a 62% decrease in likelihood of being in the Fresh Fruits & Vegetables class versus the Buy All class (95% CI=0.19;0.76; $p=.006$).

Being a member in the Buy Nothing class compared with the Buy All was 26% less likely for female participants (OR=0.74; $p=.025$); 2% less likely for every five additional years of age (OR=0.98; $p=.003$), 37% less likely for every additional child being shopped for (OR=0.63; $p=.000$), and 45% less likely for households participating in

public assistance programs ($OR=0.55$; $p=.001$) (Table 5.5). Finally, membership in the Fresh Fruits & Vegetables class was compared to membership in the Meat & Potatoes class. When compared with the Meat & Potatoes class, female participants were 354% more likely to be in the Fresh Fruits & Vegetables class ($OR=3.54$; $p=.002$), every additional five years of age was associated with a 5% increase in the likelihood of being in the Fresh Fruits & Vegetables class ($OR=1.05$; $p=.001$), every additional year of education was associated with a 37% increase in the likelihood of being in the Fresh Fruits & Vegetables class ($OR=1.37$; $p=.006$), and participants in public assistance programs were 59% less likely to be in the Fresh Fruits & Vegetables class ($OR=0.41$; $p=.038$).

DISCUSSION

Principal Findings

This research provided two principal results. First, latent class analysis of the EFSNE market basket revealed distinct underlying dietary patterns. Specifically, four different classes emerged: Buy All, Meat & Potatoes, Fresh Fruits & Vegetables, and Buy Nothing. Second, latent class regression revealed that membership in the classes were associated with sociodemographic factors.

Implications

Investigations into dietary behaviors are abundant in the nutrition literature. However, the methods commonly used in that research present limitations. For example, the outcome of fruit and vegetable purchasing or consumption is often used to represent dietary quality (Cassady, Jetter, & Culp, 2007; Robinson, 2008; Stewart, Blisard, & Joliffe, 2003; Yoo et al., 2005). Studies that have used market basket approaches to measure total diet often analyze food groups in isolation (Giskes, Van Lenthe, Brug, Mackenbach, & Turrell, 2007; Ricciuto et al., 2006). While informative, these approaches are not meant to assess the whole diet. Latent class analysis allows for an improved representation of real-life dietary patterns through a more holistic analysis technique.

There are very limited uses of latent variable methodology to measure dietary patterns (Harrington, Dahly, Fitzgerald, Gilthorpe, & Perry, 2014; Padmadas, Dias, & Willekens, 2005; Sotres-Alvarez, Herring, & Siega-Riz, 2010). Only one study in the literature took place in the U.S. and its sample was limited to pregnant women in North Carolina (Sotres-Alvarez et al., 2010). Other studies were conducted in Ireland and India and included limited samples; adults 50 to 69 years of age and women only, respectively (Harrington et al., 2014; Padmadas et al., 2005). In two instances, larger selections of foods were used for the latent class analysis; 23 items and 98 items, respectively (Harrington et al., 2014; Sotres-Alvarez et al., 2010). All of these studies measured food consumption through food frequency questionnaires, whereas, our research used a

purchasing as a proxy for consumption at the household level. Therefore, making direct comparisons between findings is challenging.

Despite differing study designs, findings from previous studies and our research exhibit similarities. Two of the studies revealed three-class dietary patterns and one indicated a five-class pattern. Harrington et al. found that class structure was distinguished by the consumption of three items: animal products, fruits and vegetables, and sweets (2014). Sotres-Alvarex et al. found similar differences in the consumption of fruits and vegetables, but because of the large number of food items used, interpreting the classes was more difficult (2010). These study findings resemble our results in that two of the classes in our research were also structured based on purchases of fruit and vegetables, and meat. The remaining two classes in our research were based the extent to which participants purchased all or none of the items.

Interestingly, our findings demonstrate that the largest class by size was the Buy All class. This indicated that a significant portion of the participants were likely to purchase all of the market basket items. However, interpretation of the classes is challenging. Previous studies interpreted latent class findings in terms of their healthfulness in the context of nutrient intakes, chronic disease prevalence and maternal health (Harrington et al., 2014; Padmadas et al., 2005; Sotres-Alvarez et al., 2010). Our research attempts to understand the latent classes in the context of a Northeast regional food system. For example, given the nature of the market basket items, the Buy All class may be indicative of a diet that could be regionally self-reliant. By contrast, the Buy Nothing class may represent a dietary pattern that is less reliant. Despite the fact that the market basket items accounted for over 70% of the regional food items in all but one of

the project stores, these items may not fully represent a regionally food secure diet.

Future market basket research will improve our understanding of dietary patterns and regional food security.

Interpreting the Meat & Potatoes and Fresh Fruits & Vegetables classes is more difficult. By one measure the Meat & Potatoes class was more likely to purchase four of the items compared with three in the Fresh Fruits & Vegetables class. However, a produce-focused diet like the one represented by the Fresh Fruits & Vegetables class could require less agricultural land, and therefore may increase the carrying capacity of a regional food system (Peters, Wilkins, & Fick, 2007). In some cases, high fat vegetarian diets required more land than diets including some meat (Peters et al., 2007). Research also demonstrates that diets that eliminate meat products produce significantly fewer greenhouse gas emissions compared with omnivorous diets, suggesting that the Fresh Fruits and Vegetables class may be more sustainable (Heller & Keoleian, 2014). Furthermore, diets higher in plant products like the Fresh Fruits & Vegetables class may improve health compared to diets high in red meat (Appleby & Key, 2016; Dinu, Abbate, Gensini, Casini, & Sofi, 2016; Pan et al., 2012). Again, further research could add to the significance of these patterns.

Because of the limited applications of latent variable methods in the literature we drew on the broader nutrition literature, when necessary, to provide context to the results of the latent class regression analyses. Overall, this research found that class membership was associated with sociodemographic factors. Our findings also demonstrate that females were more likely to be members of the Buy All and Fresh Fruits & Vegetables classes. Harrington et al. found similar relationships, showing that females were more

likely to be in the healthy diet class versus Western diet class (2014). This observation is also supported in the nutrition literature, where females were found to purchase significantly less meat (Ricciuto et al., 2006). Age was also a predictor of being in the Buy All and Fresh Fruits & Vegetables. Sotres-Alvarez et al. also found that age was a predictor of being in a healthy diet class versus an unhealthy class, with older participants more likely to be in the former (2010). However, age did not play a role in class membership in other latent variable studies (Harrington et al., 2014; Padmadas et al., 2005). Greater education was also associated with membership in the Fresh Fruits & Vegetables class, which is widely supported in the latent variable and nutrition literature (Handbury et al., 2015; Padmadas et al., 2005; Ricciuto et al., 2006; Sotres-Alvarez et al., 2010).

Participants who indicated they were shopping for children under the age of five were more likely to be in the Buy All class. The nutrition and food security literature point to households with added children as more likely to increase their spending on food, which may lead to the purchasing of a larger variety of foods (Yoo et al., 2005). Store location was not a predictor in membership of any of the classes. Much of the food security and nutrition literature that focuses on the role of urban and rural settings does so through the mechanisms of food availability and accessibility. Because we intentionally selected market basket items that were staple foods and insured that they were available in all project stores, the role of availability could not be measured. Nonetheless, these findings suggest that preferences for the market basket items do not differ from rural to urban settings.

Finally, participation in public assistance was associated with class membership in the Buy All and Meat & Potatoes classes. It is difficult to disentangle the mechanisms underlying the relationship between participation and class membership. This variable may be capturing the effect of government safety net programs, such as SNAP, which may provide the resources to purchase more of the items; or it may be indicating low-income households since public assistance is income-based. Research on food security indicates that 62% of food insecure households participate in some form of public assistance (Coleman-Jensen et al., 2014). What is revealing about these findings is that public assistance participants in our sample were more likely to be in the class with the most diverse dietary pattern, including fruits and vegetables. This finding may run contrary to the narrative that participants in SNAP and other forms of public assistance purchase predominantly nutrient-poor foods.

Strengths and Limitations

The latent variable methods employed in this research allowed for the meaningful classification of dietary patterns based on responses that would otherwise be unaccounted for in using simple counts or indices. This provides a more holistic assessment of dietary patterns. Furthermore, this study is one of very few food system studies that employ latent variable analyses and adds to only one other study that takes place in the U.S. This research also uses data from a large sample from the EFSNE project. This improves the identifiability of the latent class model and reduces the likelihood of random sampling error, which may improve the generalizability of the results from the sample to the target

population.

Several limitations must also be considered in interpreting the results from this research. First, the cross-sectional research design does not allow for causality to be assessed between the outcome of dietary patterns and the independent variables that may be associated with those patterns. While this may be a threat to internal validity, some predictors like age, gender and geographic location are fixed, and, therefore are not expected to have temporal ordering with the outcome of interest. Additionally, the aims of this research are to further understand current dietary patterns of regionally significant foods, so a cross-sectional survey is an appropriate manner in which to measure this outcome. Furthermore, while the selection of the eight market basket items was systematic and deliberate, they do not represent a total diet and should not be interpreted as such.

Another limitation of this study was the use of a non-probability sampling method. For both the participating supermarkets and the participating customers, a convenience sample was used in recruiting. Using a non-random sampling method introduces systematic sampling bias, which may reduce the external validity of the findings beyond the target population. However, the target population for this research was customers at supermarkets, so convenience sampling at the supermarkets was appropriate in lieu of a sampling frame of customers at those stores. It is also important to consider that the EFSNE project had goals beyond what is proposed here, including research that required frequent participation with storeowners, management and their suppliers. Therefore, a convenience sample was necessary for recruiting the supermarkets to insure that these goals could be met.

CONCLUSIONS

The findings from this study provided insight into the distinct dietary patterns exhibited by a sample of supermarket customers in the Northeast. Specifically, we assessed the purchases of eight market basket items selected for their significance to a Northeast regional food system. Findings suggest that there were four distinct patterns in which participants purchased the EFSNE market basket items. This study was unique in its analytic methodology and, therefore, adds to the body of literature regarding dietary patterns and their relationships with sociodemographic factors. The use of a regional market basket and the focus on a future regional food system are also unique to the literature. Findings indicated that sociodemographic factors were associated with the dietary patterns, which may be important for our understanding of regional food security. Future research should continue to investigate the connections between diet, regional food systems and the opportunity to improve regional food security.

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Table 5.1 Sociodemographic Characteristics of EFSNE Participants (N=1,996)

Characteristic	n	Statistics
Sex		
Female	1,265	65.9%
Median age		48.3
Age		
18-64	1,675	85.0%
65 and Older	296	15.0%
Median years of education		12.0
Years of education		
Less than 12	290	14.5%
12 to 15	1,197	60.0%
16 and over	509	25.5%
Household size		3.0
Children <5	481	24.1%
Store location		
Urban	1,594	79.9%
Rural	402	20.1%
Household receiving public assistance	859	43.5%

Note: Totals may not sum to 100% because of missing data.

Figure 5.1 Purchasing of EFSNE Market Basket Items: Number and Types (N=1,996)

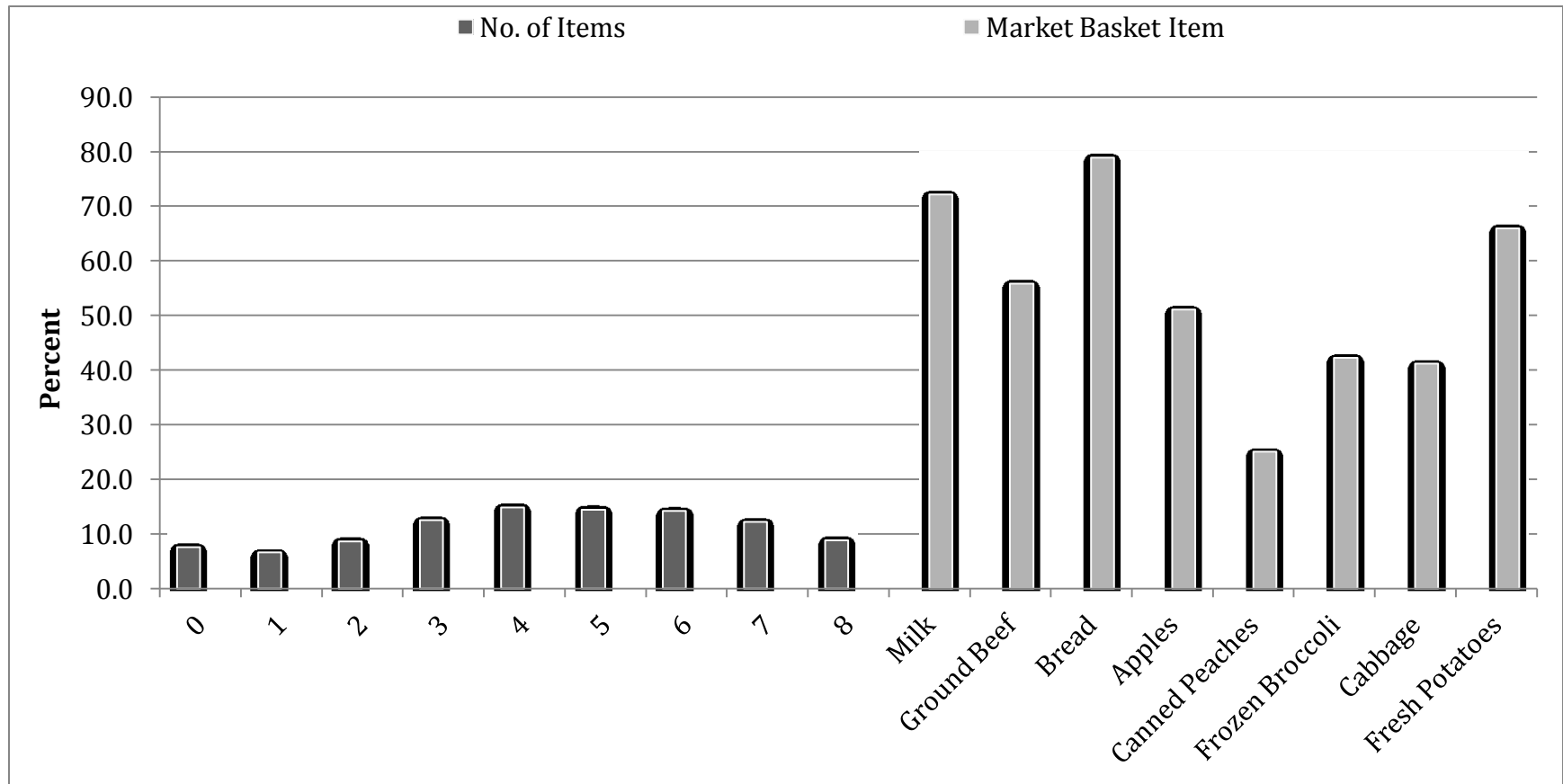


Table 5.2 Latent Class Analyses of EFSNE Market Basket Purchases: Model Fit Statistics (N=1,996)

Classes	$X^2(p)$	LRT (<i>p</i>)	AIC	BIC	LMR (<i>p</i>)	BLRT (<i>p</i>)	Entropy
2	.000	.000	17,6916.316	17,786.498	.000*	.000*	.750*
3	.000	.000	17,314.819	17,460.390	.000*	.000*	.723*
4	.778*	.154*	17,227.651	17,423.612*	.000*	.000*	.672*
5	.999*	.896*	17,191.764	17,438.116	.003*	.000*	.616
6	1.00*	.980*	17,187.192*	17,483.933	.061	.133	.623

Note: $p < .05$ are in boldface

* Preferred model fit

Table 5.3 Latent Class Analysis of EFSNE Market Basket Purchases: Latent Class and Conditional Probabilities (N=1,841)

Four-Class Model						
<i>Market Basket Purchases</i>			<i>Latent Class Probabilities</i> (%, n)			
			<u>Class 1</u>	<u>Class 2</u>	<u>Class 3</u>	<u>Class 4</u>
			(35.9%, 661)	(22.9%, 422)	(23.9%, 440)	(17.3%, 318)
<i>Item</i>	<i>n</i>	<i>%</i>	<i>Conditional Probabilities</i> Prob. (SE)			
Milk	1,321	72.2	.934 (.022)	.881 (.033)	.661 (.053)	.176 (.041)
Ground beef	1,024	55.9	.870 (.050)	.700 (.103)	.305 (.064)	.113 (.024)
Bread	1,445	79.0	.958 (.007)	.979 (.019)	.734 (.047)	.286 (.037)
Apples	938	51.1	.787 (.038)	.362 (.060)	.583 (.048)	.058 (.021)
Canned peaches	456	25.1	.546 (.061)	.134 (.042)	.098 (.060)	.035 (.020)
Frozen broccoli	775	42.3	.792 (.056)	.294 (.063)	.300 (.094)	.037 (.023)
Cabbage	752	41.2	.818 (.064)	.112 (.036)	.388 (.104)	.034 (.016)
Fresh potatoes	1,212	66.0	.989 (.011)	.592 (.083)	.670 (.077)	.081 (.026)
<i>Interpretation</i>			Buy All	Meat & Potatoes	Fresh Fruits & Vegetables	Buy Nothing

Figure 5.2 Conditional Probabilities for a Latent Class Analysis of EFSNE Regional Market Basket (N=1,841)

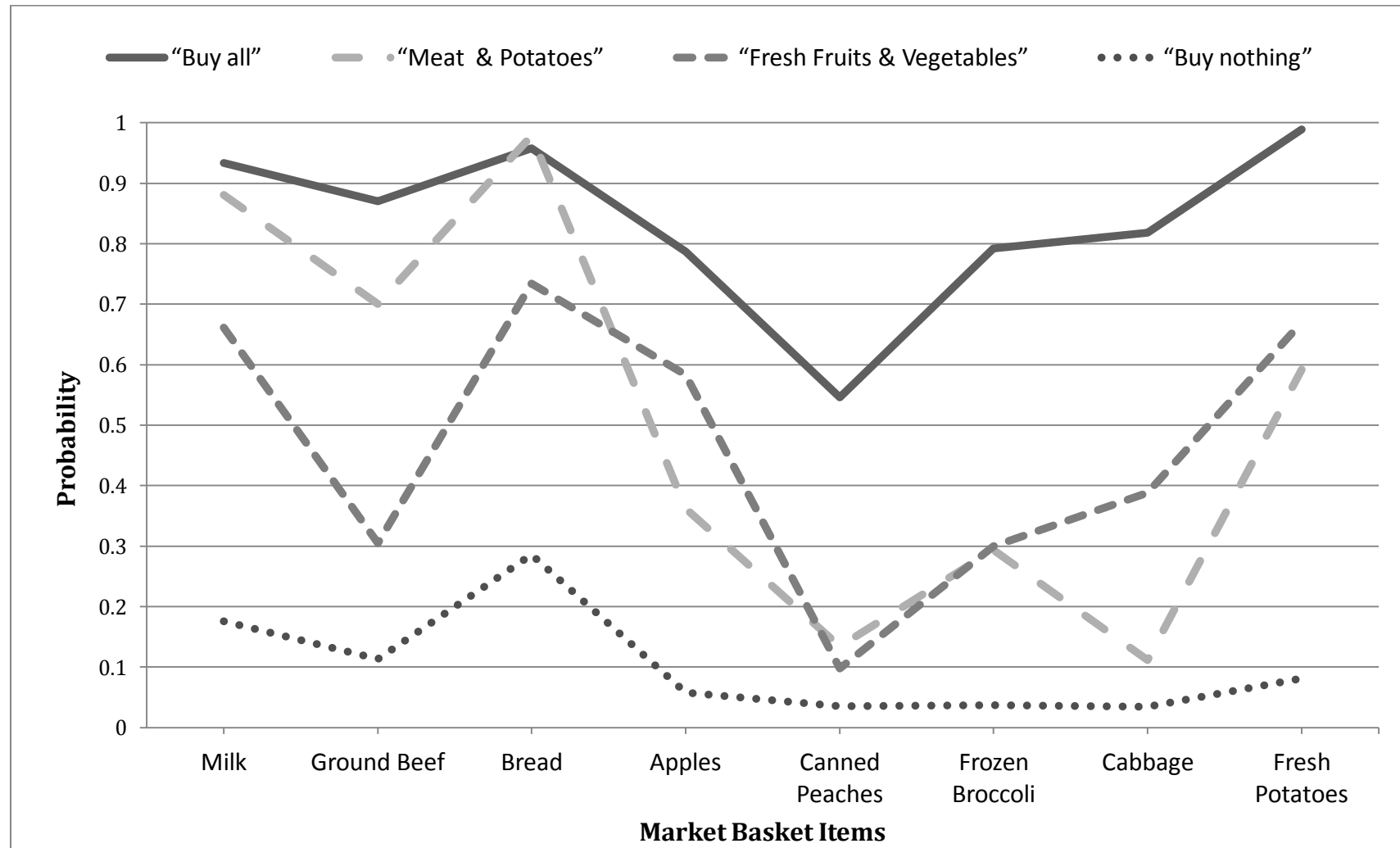


Table 5.4 Multivariate Latent Class Regression Analyses of EFSNE Market Basket Purchases (N=1,841)

	Meat & Potatoes vs Buy All			Fresh Fruits & Vegetables vs Buy All			Buy Nothing vs Buy All			Fresh Fruits & Vegetables vs Meat & Potatoes		
	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
Sex												
Male	Ref.			Ref.			Ref.			Ref.		
Female	0.57	0.37, 0.87	.010	2.02	0.88, 4.62	.096	0.74	0.57, 0.96	.025	3.54	1.56, 8.02	.002
Age (5 years)	0.96	0.95, 0.97	.000	1.00	0.97, 1.03	.908	0.98	0.97, 0.99	.003	1.05	1.02, 1.08	.001
Education years	1.09	0.95, 1.25	.220	1.49	1.28, 1.73	.000	1.16	1.00, 1.35	.052	1.37	1.10, 1.71	.006
Children <5	0.85	0.65, 1.13	.260	0.69	0.49, 0.96	.028	0.63	0.51, .077	.000	0.81	0.55, 1.17	.261
Location												
Urban	Ref.			Ref.			Ref.			Ref.		
Rural	1.75	0.65, 4.75	.268	1.49	0.40, 5.49	.550	1.42	0.56, 3.58	.454	0.85	0.18, 3.96	.834
Public assistance												
No	Ref.			Ref.			Ref.			Ref.		
Yes	0.91	0.59, 1.40	.668	0.38	0.19, 0.76	.006	0.55	0.39, 0.78	.001	0.41	0.18, 0.95	.038

Note: *p* < .05 are in boldface

CHAPTER 6
INTEGRATIVE SUMMARY

SUMMARY OF FINDINGS

The purpose of this research was to explore the dietary characteristics of the Northeast to better understand the food needs of the region and the potential of a regional food system to help meet those needs. The findings increase our understanding of consumers in the region, their dietary characteristics, and the relationships between those characteristics and sociodemographic factors.

Aim 1: Describe characteristics relevant to regional food security in the Northeast.

Summary of Findings

In this review we attempted to characterize the Northeast on two distinct dimensions in an effort to start the process of understanding the region's food needs and their relationships with regional food security. First, sociodemographic factors of the region and the U.S. were reviewed. Sociodemographics have shown to be related with dietary characteristics in the literature. Our results indicated that the sociodemographic characteristics of the Northeast region differed from those of the nation overall. This suggests that dietary characteristics of the region may be unique as well. Additional research is needed to advance our understanding of dietary characteristics at the regional level. Additionally, continued research on the relationship between diet and sociodemographic factors will better distinguish their associations in the Northeast.

Second, we assessed the environmental factors of the region to better our understanding of the opportunities for a future regional food system to improve regional food security from a food production perspective. Land use data demonstrated that a comparatively small portion of the land in the Northeast was used for agriculture and that most of this land was used for food animal production or was not in production at all. Regional self-reliance measures showed wide variations in self-reliance across several food categories. However, these findings were limited in that they measure homogeneous levels of consumption and are unable to assess variations in diet across the region. Further research can elucidate specific dietary characteristics, the potential variation in these characteristics in the Northeast, and their relationship with regional food security.

Aim 2: Explore dietary characteristics in the Northeast region and their associations with sociodemographic factors.

Summary of Findings

This research sought to improve our understanding of the dietary characteristics in the Northeast region. Specifically, we attempted to assess the relationships between dietary characteristics and sociodemographic factors. Findings revealed the most commonly purchased food categories and the portion of participant's food budget that is devoted to those categories. Sociodemographics were consistently associated with the purchasing of specific categories. Some of our findings supported the existing literature.

Other findings provided new insights into the associations between sociodemographics and diet characteristics at the regional level. Continued research is needed that further investigates distinct dietary patterns and more directly connects them to a future regional food system.

Aim 3: Identify specific dietary patterns using a regionally significant market basket and their associations with sociodemographic factors.

Summary of Findings

This study sought to investigate distinct patterns at the regional level and attempted to connect these patterns directly with a regional food system. The findings provided insights into these patterns exhibited by a sample of supermarket customers in the Northeast. Specifically, we assessed the purchases of eight market basket items selected for their significance to a Northeast regional food system. Findings suggest that there were four distinct patterns in which participants purchased the EFSNE market basket items. These patterns may be significant to regional food security because of the extent to which they contain the market basket items. Findings indicated that sociodemographic factors were associated with the dietary patterns, which may be important for our understanding of the antecedents of regional food security in the Northeast. This study was unique in its analytic methodology and, therefore, adds to the body of literature regarding dietary patterns and their relationships with

sociodemographic factors. The use of a regional market basket and the focus on a future regional food system are also unique to the literature. Future research should continue to investigate the connections between diet, regional food systems and the opportunity to improve regional food security.

INTEGRATION OF FINDINGS

The findings presented here enhance our knowledge of the potential for a regional food system in the Northeast to improve regional food security. First, our results revealed that the Northeast region was unique in many sociodemographic factors that are likely to influence the region's diet. We also found that the region includes a significant amount of land that could be used for future agricultural production. Currently, however, the region does not produce much of the food that it consumes. Our findings from the analysis of the Bureau of Labor Statistics Diary Survey demonstrate that sociodemographic factors were related to variations in dietary characteristics at a regional level. Results offered support for the extant literature but also shed new light on how these dietary characteristics at a regional level (Beydoun & Wang, 2008; Coleman-Jensen, Gregory, & Singh, 2014; Harrington, Dahly, Fitzgerald, Gilthorpe, & Perry, 2014; Leung et al., 2012; Ricciuto, Tarasuk, & Yatchew, 2006; Sotres-Alvarez, Herring, & Siega-Riz, 2010; Yoo et al., 2005). We also identified specific dietary patterns within a regionally specific market basket of foods that allowed us to more explicitly assess dietary characteristics within a regional food systems context. Using the Ecological Systems Theory allowed for greater

understanding of the extent to which sociodemographic factors were related to dietary characteristics and possibly to regional food security (Bronfenbrenner, 1977; McLeroy, Bibeau, Steckler, & Glanz, 1988). The findings from this research are organized by ecological level and presented in Table 6.1. These findings can serve as important foundations for additional research and food system activities that attempt to achieve regional food security.

IMPLICATIONS AND RECOMMENDATIONS

The findings from this research may inform continued strategies to assess and, perhaps eventually implement, regional food security initiatives across the food system and in various disciplines. There is currently less agricultural land in the Northeast than in the past and what is being used is predominantly used for food animal production. If regional food systems are to prosper, greater research and resources need to focus on the potential for the land in the region to both remain in and return to agricultural production. Specifically, the role of diverse, sustainable, small and mid-size farms should be addressed. These farms may provide opportunities for more diverse food production and may be able to collaborate with regional processing, distribution and retail stakeholders, thereby, increasing economic returns to the region (Clark & Inwood, 2016).

Future research must also address the specific benefits and drawbacks of regional food systems for all stakeholders. Many of the qualities of regional food systems have been proposed but have not been adequately assessed in the literature. Continued research

into proposed transportation efficiencies, improved biodiversity, greater economic development and effective management would bolster the case for more fully developed regional food systems. Further research into tracking food flows throughout supply chains, including greater insights into sourcing of processed foods would also improve our understanding of regional self-reliance.

Findings from an EFSNE project study demonstrated that among consumers, the concept of regional food is harder to understand compared with local food systems. As findings from our research suggest, several food categories have low measure of self-reliance. This indicates that marketing regional food systems to consumers may not be an efficient use of resources at this point. Initiatives focused on regional supply chains may offer greater opportunities for development of a Northeast food system. Once supply chains can adapt to emphasizing regional production, processing, distribution and retail, consumers may be more likely to understand the benefits of a regional system and increase their demand for these products.

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Table 6.1. Application of Ecological Systems Theory to Dietary Characteristics and Regional Food Security

Level of Influence ^a	Factor	Findings
<i>Environmental</i>	Land use; Agricultural production	<ul style="list-style-type: none"> • A small amount of land is used for agricultural production • A majority of land used for food is in food animal production • Current regional self-reliance varied by food category
<i>Public Policy</i>	Food assistance programs	<ul style="list-style-type: none"> • SNAP participation was related to decreased purchasing of fruits and snacks and sweets • SNAP participation increased the likelihood of Buy All class membership
<i>Community</i>	Retail food environment; Urbanicity	<ul style="list-style-type: none"> • Retail food environments differed in the region but their effect was unable to be measured • Urbanicity did not have an effect on class membership for the regional market basket
<i>Interpersonal</i>	Household composition; Children	<ul style="list-style-type: none"> • Having children increased the likelihood of purchasing of all categories of food and increased the likelihood of Buy All class membership
<i>Intrapersonal</i>	Age; Sex; Race; Ethnicity; Education; Income	<ul style="list-style-type: none"> • Being older and being female were associated with being purchasing more food categories and membership in the Fresh Fruits and Vegetables and Buy All classes • Black and Asian participants were more likely to purchase poultry and seafood, respectively, but less likely to purchase snacks and sweets and mixed dishes • Hispanic participants were more likely to purchase several animal proteins but also non-meat proteins and fruits • Having a greater income and greater education was associated with decrease in likelihood of purchasing several food categories • Greater education increased likelihood of being in the Fresh Fruits and Vegetables class.

^aAdapted from McLeroy et al. (1988)

APPENDICES

Appendix A: Sociodemographic Characteristics by State

Appendix A.1: Population, Sex and Age of Residents in the Northeast United States by State

Appendix A.2: Educational Attainment of Residents in the Northeast United States by State

Appendix A.3: Income, Poverty Status and Unemployment of Residents in the Northeast United States by State

Appendix A.4: Race and Ethnicity of Residents in the Northeast United States by States by State

Appendix A.5: Composition of Households in the Northeast United States by State

Appendix A.6: Urbanicity and Population Density in the Northeast United States by States

Appendix A.7: Retail Food Environment of the Northeast United States by States

Appendix A.8: Federal Food Program Participation in the Northeast United States by State

Appendix B: Categorization of USDA Food Categories and Diary Survey Items

Appendix B.1: Categorization of USDA Food Categories and Diary Survey Items

Appendix C: EFSNE Consumption Project Documents

Appendix C.1: EFSNE Recruitment: Sampling Characteristics of Supermarkets

Participating in EFSNE

Appendix C.2: EFSNE Customer Intercept Survey

APPENDIX A

Sociodemographic Characteristics by State

APPENDIX A.1

Population, Sex and Age of Residents in the Northeast United States by State ^a

	Total population	Percent female	Median age	% 18-64 years	% 65 years and over
Connecticut	3,572,213	51.3	40.0	63.0	14.3
Delaware	900,131	51.5	38.7	62.6	14.5
District of Columbia	605,759	52.7	33.9	71.4	11.4
Maine	1,329,084	51.1	42.8	63.4	16.0
Maryland	5,785,496	51.6	37.9	64.3	12.4
Massachusetts	6,560,595	51.6	39.1	64.5	13.9
New Hampshire	1,317,474	50.7	41.1	64.6	13.7
New Jersey	8,793,888	51.3	38.9	63.0	13.6
New York	19,398,125	51.6	38.0	64.1	13.6
Pennsylvania	12,699,589	51.3	40.1	62.6	15.5
Rhode Island	1,052,471	51.7	39.4	64.3	14.6
Vermont	625,498	50.7	41.7	64.8	14.7
West Virginia	1,850,481	50.8	41.3	62.9	16.2
<i>Northeast Region</i>	<i>64,490,804</i>	<i>51.4</i>	<i>39.0*</i>	<i>63.7</i>	<i>14.1</i>
<i>United States</i>	<i>309,138,711</i>	<i>50.8</i>	<i>37.2</i>	<i>62.9</i>	<i>13.2</i>

Note: * Weighted average

^a (United States Census Bureau, 2012a)

APPENDIX A.2

Educational Attainment of Residents in the Northeast United States by State ^a

	% Less than 9th grade	% 9th to 12th grade	% High school graduate	% Some college	% Bachelor's degree	% Graduate or professional degree
Connecticut	4.5	6.5	27.9	17.6	20.3	15.8
Delaware	4.1	8.2	31.6	20.3	17.1	11.4
District of Columbia	4.8	7.7	19.1	14.3	22.5	28.7
Maine	3.5	5.9	34.2	20.1	17.6	9.8
Maryland	4.5	7.0	26.0	19.9	20.0	16.4
Massachusetts	4.9	6.0	25.9	16.6	22.2	16.8
New Hampshire	2.8	5.8	29.3	19.1	21.2	12.3
New Jersey	5.5	6.6	29.2	17.1	22.0	13.4
New York	6.9	8.2	27.3	16.5	18.6	14.1
Pennsylvania	3.8	7.9	37.2	16.5	16.6	10.4
Rhode Island	6.7	8.6	27.5	18.4	18.6	12.2
Vermont	3.0	5.7	31.2	17.2	20.7	13.5
West Virginia	6.2	10.4	40.9	6.1	11.0	6.9
<i>Northeast Region</i>	<i>5.3</i>	<i>7.5</i>	<i>29.9</i>	<i>16.8</i>	<i>19.1</i>	<i>13.6</i>
<i>United States</i>	<i>6.0</i>	<i>8.2</i>	<i>28.2</i>	<i>21.3</i>	<i>17.9</i>	<i>10.6</i>

Note: Totals do not sum to 100% because table omits individuals who received an associate's degree.

^a (United States Census Bureau, 2012a)

APPENDIX A.3

Income, Poverty Status and Unemployment of Residents in the Northeast United States by State

	Median household income ^a	% Below poverty ^a	Percent of labor force unemployed ^b
Connecticut	\$69,519	10.0	8.5
Delaware	\$60,119	11.5	7.2
District of Columbia	\$64,267	18.5	8.9
Maine	\$48,219	13.3	7.5
Maryland	\$72,999	9.4	6.9
Massachusetts	\$66,658	11.0	6.6
New Hampshire	\$64,925	8.4	5.5
New Jersey	\$71,637	9.9	9.4
New York	\$57,683	14.9	8.6
Pennsylvania	\$52,267	13.1	7.8
Rhode Island	\$56,102	13.2	10.5
Vermont	\$54,168	11.6	5.0
West Virginia	\$40,400	17.6	7.5
<i>Northeast Region</i>	<i>\$60,779*</i>	<i>12.5</i>	<i>8.0</i>
<i>United States</i>	<i>\$53,046</i>	<i>14.9</i>	<i>8.2</i>

Note: *Weighted median

^a (United States Census Bureau, 2012b)

^b (Bureau of Labor Statistics, 2012)

APPENDIX A.4

Race and Ethnicity of Residents in the Northeast United States by States by State ^a

	% Hispanic	% White	% Black or African American	% Asian
Connecticut	13.4	78.4	10.0	3.9
Delaware	8.1	70.5	21.4	3.2
District of Columbia	9.3	39.5	51.1	3.5
Maine	1.3	95.3	1.1	1.1
Maryland	8.2	58.9	29.4	5.6
Massachusetts	9.6	81.0	6.8	5.4
New Hampshire	2.8	94.2	1.2	2.2
New Jersey	17.7	69.6	13.5	8.4
New York	17.7	66.0	15.7	7.5
Pennsylvania	5.7	82.5	10.8	2.8
Rhode Island	12.5	81.7	6.1	3.0
Vermont	1.5	95.3	0.9	1.3
West Virginia	1.2	93.9	3.1	0.7
<i>Northeast Region</i>	<i>11.8</i>	<i>73.7</i>	<i>14.2</i>	<i>5.4</i>
<i>United States</i>	<i>16.4</i>	<i>74.2</i>	<i>12.6</i>	<i>4.8</i>

^a (United States Census Bureau, 2012a)

APPENDIX A.5

Composition of Households in the Northeast United States by State ^a

	Total households	Average household size	% Family households with children under 18 years
Connecticut	1,360,184	2.5	30.6
Delaware	334,076	2.6	28.4
District of Columbia	261,192	2.2	17.3
Maine	553,208	2.3	25.5
Maryland	2,138,806	2.6	30.5
Massachusetts	2,525,694	2.5	28.8
New Hampshire	516,845	2.5	28.9
New Jersey	3,186,878	2.7	32.1
New York	7,230,896	2.6	28.9
Pennsylvania	4,959,633	2.5	27.1
Rhode Island	410,639	2.5	27.5
Vermont	256,830	2.3	26.4
West Virginia	742,674	2.4	24.6
<i>Northeast Region</i>	<i>24,477,555</i>	<i>2.6*</i>	<i>28.8</i>
<i>United States</i>	<i>115,226,802</i>	<i>2.6</i>	<i>29.9</i>

Note: *Weighted median

^a (United States Census Bureau, 2012c)

APPENDIX A.6

Urbanicity and Population Density in the Northeast United States by States ^a

	State total area (miles)	% Urban area	% Population urban
Connecticut	4,842	37.7	88.0
Delaware	1,949	20.9	83.3
District of Columbia	61	100.0	100.0
Maine	30,843	1.2	38.7
Maryland	9,707	20.7	87.2
Massachusetts	7,800	38.3	92.0
New Hampshire	8,953	7.2	60.3
New Jersey	7,354	39.7	94.7
New York	47,126	8.7	87.9
Pennsylvania	44,743	10.5	78.7
Rhode Island	1,034	38.8	90.7
Vermont	9,217	1.7	38.9
West Virginia	24,038	2.7	48.7
<i>Northeast Region</i>	<i>197,667</i>	<i>10.7</i>	<i>84.3</i>
<i>United States</i>	<i>3,531,905</i>	<i>3.0</i>	<i>80.7</i>

^a (United States Census Bureau, 2010)

APPENDIX A.7

Retail Food Environment of the Northeast United States by States ^a

	Density (Establishments per 10,000 people)						% SNAP farmers' markets
	Supermarkets and grocery stores	Convenience stores	Meat markets	Fish and seafood markets	Fruit and vegetable markets	Farmers' markets	
Connecticut	2.2	0.9	0.1	0.1	0.5	0.4	15.4
Delaware	1.8	1.0	0.2	0.2	0.2	0.4	38.9
District of Columbia	3.2	1.8	0.1	0.1	0.0	0.9	79.6
Maine	2.7	1.6	0.2	0.4	0.0	0.7	43.8
Maryland	2.1	1.0	0.1	0.2	0.1	0.3	28.2
Massachusetts	2.2	2.0	0.2	0.2	0.6	0.5	48.0
New Hampshire	2.0	1.5	0.2	0.1	0.0	0.7	32.3
New Jersey	3.0	1.4	0.3	0.1	0.1	0.2	19.2
New York	5.2	1.0	0.4	0.2	0.5	0.3	41.5
Pennsylvania	2.1	0.8	0.3	0.1	1.6	0.2	26.6
Rhode Island	2.0	1.4	0.2	0.2	0.1	0.5	48.1
Vermont	3.7	1.3	0.2	0.0	0.3	1.5	55.2
West Virginia	1.9	0.7	0.1	0.0	0.0	0.5	33.3
<i>Northeast Region</i>	<i>3.2</i>	<i>1.1</i>	<i>0.3</i>	<i>0.1</i>	<i>0.0</i>	<i>0.4</i>	<i>37.2</i>
<i>United States</i>	<i>2.1</i>	<i>0.8</i>	<i>0.2</i>	<i>0.1</i>	<i>0.1</i>	<i>0.3</i>	<i>31.6</i>

^a (United States Census Bureau, 2012d)

APPENDIX A.8

Federal Food Program Participation in the Northeast United States by State

	% Households receiving SNAP ^a	% Women receiving WIC ^b	% Students in NSLP ^c	% Students in SBP ^c
Connecticut	9.5	0.7	15.8	54.1
Delaware	10.8	1.0	29.8	74.2
District of Columbia	12.9	1.3	44.6	63.9
Maine	15.8	0.8	23.7	57.2
Maryland	8.4	1.2	22.3	50.6
Massachusetts	10.7	0.8	15.8	56.2
New Hampshire	7.3	0.6	12.8	55.3
New Jersey	6.8	0.9	16.2	54.2
New York	13.5	1.3	23.9	66.7
Pennsylvania	11.1	0.9	19.5	64.1
Rhode Island	12.5	1.0	23.4	56.7
Vermont	12.2	1.0	26.2	60.3
West Virginia	14.6	1.2	40.4	71.2
<i>Northeast Region</i>	<i>11.1</i>	<i>1.0</i>	<i>21.0</i>	<i>60.7</i>
<i>United States</i>	<i>11.4</i>	<i>1.3</i>	<i>25.9</i>	<i>63.8</i>

^a (United States Census Bureau, 2012b)

^b (United States Department of Agriculture, 2012b)

^c (United States Department of Agriculture, 2012a)

APPENDIX B

Categorization of USDA Food Categories and Diary Survey Items

APPENDIX B.1

Categorization of USDA Food Categories and Diary Survey Items

USDA Category ^a	Diary Survey Items ^b
Milk and dairy	Fresh milk; cheese; other dairy products including powdered milk and fresh, canned and non-frozen yogurt
<i>Proteins</i>	
Meats	Ground beef; chuck roast; round roast; other roast; round steak; sirloin steak; other steak; other beef; pork chops; ham; other pork; lamb and organ meats; mutton, goat game
Poultry	Fresh and frozen whole chicken; fresh or frozen chicken parts; other poultry
Seafood	Canned fish, seafood and shellfish; fresh fish and shellfish; frozen fish and shellfish
Eggs	Eggs
Cured meats	Frankfurters; bologna, liverwurst, salamis; other lunchmeat; bacon; pork sausage; canned ham
Non-meat proteins	Dried peas; dried beans; canned beans; nuts
Grains	Flour; prepared flour mixes; cereal; rice; pasta, cornmeal, other cereal products; white bread; bread other than white; fresh biscuits, rolls, muffins
Fruit	Apples; bananas; oranges; other fresh fruits; citrus fruits; frozen fruits; canned fruits; dried fruits
Vegetables	Potatoes; lettuce; tomatoes; other fresh vegetables; frozen vegetables; canned corn; miscellaneous canned vegetables; other processed dried vegetables; dried carrots, onions, leafy greens and cabbage; prepared salads
Snacks and sweets	Ice creams and frozen yogurt; cakes and cupcakes; cookies; crackers; bread and cracker products; doughnuts, sweet rolls, coffeecakes; frozen, refrigerated and canned bakery products; fresh pies, tarts and turnovers; candy and chewing gum; potato chips and other snacks; prepared desserts
Mixed dishes	Soup; frozen meals; frozen prepared food; baby food; miscellaneous prepared foods

^a (United States Department of Agriculture, 2016)

^b (Bureau of Labor Statistics, 2013)

APPENDIX C

EFSNE Consumer Intercept Survey

APPENDIX C.1

EFSNE Recruitment: Sampling Characteristics of Supermarkets Participating in EFSNE

<u>Location</u>		<u>Characteristics</u>		<u>Participation</u>	
<i>State</i>	<i>City/County</i>	<i>Urban/ Rural</i>	<i>Poverty Rate</i>	<i>Round 2</i>	<i>Round 3</i>
Delaware	Sussex County	Rural	14.5%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Delaware	Sussex County	Rural	14.8%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Maryland	Baltimore City	Urban	40.5%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Maryland	Baltimore City	Urban	20.5%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	Madison County	Rural	11.4%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	New York City	Urban	28.3%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	New York City	Urban	28.3%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	Syracuse	Urban	39.1%	<input type="checkbox"/> ✓	
New York	Syracuse	Urban	5.9%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
New York	Onondaga County	Rural	8.7%		<input type="checkbox"/> ✓
Pennsylvania	Pittsburgh	Urban	10.0%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Vermont	Essex	Rural	20.2%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
Vermont	Essex	Rural	20.2%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
West Virginia	Charleston	Urban	20.1%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓
West Virginia	Charleston	Urban	20.1%	<input type="checkbox"/> ✓	<input type="checkbox"/> ✓

Note: ✓ Participated in data collection

APPENDIX C.2

EFSNE Costumer Intercept Survey

Intercept Survey

We are surveying food shoppers in the area to get your thoughts on the food available and purchasing habits. Your responses are confidential. We do not ask for your name, so no information associated with your name will ever be released.

ARE YOU 18 YEARS OF AGE OR OLDER?

ARE YOU ONE OF THE PRIMARY FOOD SHOPPERS IN YOUR HOUSEHOLD?

(If no to either of these questions, terminate survey)

PURPOSE:

This survey aims to learn more about food needs in this neighborhood/community. It is being conducted by Penn State University in collaboration with (insert institution). We are using the information collected for a project that is looking at increasing the availability of food produced in the Northeast region.

PROCEDURES:

The survey should last about 5-7 minutes, and it mainly asks about your opinions. People will have a wide range of answers to these questions, and all are okay. You may refuse to answer any question you wish. You will receive a \$5 gift card to (store name) for your participation.

BENEFITS:

There are no direct benefits to you from being in this survey, however, you may enjoy talking about these issues.

VOLUNTARY PARTICIPATION:

You do not have to agree to be in this study, and you may change your mind at any time.

PERMISSION TO PROCEED:

Is it okay to proceed with the survey? [Verbal Yes/No] Completion of the interview implies your consent to participate in this research. If you would like a copy of the consent section, I have one for you.

1. What is your zip code? _____
2. Do you live in the [site name]? _____ Yes _____ No
3. How satisfied are you with the overall quality of the food sold in [site name]?
☐ Very satisfied ☐ Somewhat satisfied ☐ Somewhat dissatisfied ☐ Very dissatisfied
4. How satisfied are you with the variety of foods available in [site name]?
☐ Very satisfied ☐ Somewhat satisfied ☐ Somewhat dissatisfied ☐ Very dissatisfied

5. Overall, how satisfied are you with the price of food available in [*site name*]?
☐ Very satisfied ☐ Somewhat satisfied ☐ Somewhat dissatisfied ☐ Very dissatisfied
6. Are there foods that you would like to buy but cannot find in [*site name*]?
☐ No ☐ Yes (*please list foods*)
7. How important is it to you where your food comes from?
☐ Very important ☐ Somewhat Important ☐ Somewhat Unimportant ☐ Very Unimportant
8. If you indicated that where food comes from is very or somewhat important to you, from which of the following choices would you prefer to get most of your food?
☐ Within a 100 miles radius
☐ Within (*Name your state*)
☐ Within (*Name your state*) and neighboring states
☐ From the entire Northeast region (Maine to West Virginia)
☐ Other: _____

*In the next question, I am asking about **healthy food**, which, for this survey, refers to foods like fruits and vegetables, lean meat, low-fat dairy, and whole-grain breads.*

9. Is there anything that might prevent you from buying more healthy foods?
(Read list and check all that apply)

- ☐ Taste
☐ Not available/limited availability
☐ Family Preferences
☐ Price
☐ Need more knowledge on how to prepare healthy foods
☐ Preparation Time
☐ No barriers ☐ Other: _____

10. a. Where do you do most of your food shopping? _____
(if they list more than one, add the others to d. below)

b. How often do you buy food there?

- ☐ 2 or more times a week
☐ Weekly
☐ Every 2 weeks
☐ Monthly
☐ A few times a year
☐ Other:

- c. On average, how much do you spend each time you go? (\$ per visit):

d. Where else do you shop for food (*up to two additional places*)?

If the answer in “d” includes farmers’ markets or roadside stands, skip part “e”.

e. Do you buy food at farmers’ markets, roadside stands, or other places where farmers sell directly to customers? ☐ Yes ☐ No

9. During this shopping trip or in the past month, have you purchased any of the following products **at this store**?

Milk: ☐ Yes ☐ No
If yes: ☐ fat free, 1 or 2% ☐ whole

Ground Beef: ☐ Yes ☐ No
If yes: ☐ lean ☐ regular ☐ don’t know

Bread: ☐ Yes ☐ No
If yes: ☐ whole wheat ☐ white ☐ other

Apples: ☐ Yes ☐ No
Canned Peaches: ☐ Yes ☐ No

Frozen Broccoli: ☐ Yes ☐ No
Cabbage: ☐ Yes ☐ No
Fresh Potatoes: ☐ Yes ☐ No

Now that I understand more about your experience with stores in the area, I would like to ask a just a few questions about you.

10. In what year were you born? _____

11.a. How many people in your household? _____

11.b. How many people are you usually shopping for? _____

11.c. How many of those people you are shopping for are age 5 or under?

12. ☐ Male ☐ Female

13. Does anyone in your household participate in government-funded programs? (Ex. Food Stamps, School Breakfast/Lunch, WIC, SSI, Head Start) ☐ Yes ☐ No

14. How many years of formal schooling have you completed, starting with 1st grade? _____ years

15. Do you have any other thoughts about foods that are available in this community that you would like to share?

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EDUCATION

- August 2017 Doctor of Philosophy in Social and Behavioral Sciences
 Johns Hopkins Bloomberg School of Public Health, Baltimore, MD
 Department of Health, Behavior and Society
 Dissertation: *Regional Food Systems And Food Security:
 Exploring Dietary Characteristics In The Northeast United States*
- May 2013 Master of Health Science in Social Factors in Health
 Johns Hopkins Bloomberg School of Public Health, Baltimore,
MD
 Department of Health, Behavior and Society
 Thesis: *Motivations of Local Economy in Supplemental Nutrition
 Assistance Program Use at Baltimore City Farmers' Markets*
- December 2007 Bachelor of Arts in Psychology
 University of Minnesota, Twin Cities

PROFESSIONAL EXPERIENCE

Research Assistant, April 2012 – present
Center for a Livable Future
Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

Project: *Enhancing Food Security in the Northeast*

Principal Investigator: *Anne Palmer, MAIA*

- Member on an interdisciplinary team of scientists in a United States Department of Agriculture funded multi-institutional investigation of the potential for regional food systems to improve food security in underserved communities in the Northeast
- Collaboration with social scientists, agricultural economists, public health experts and stakeholders in the design, implementation and dissemination of food systems research
- Design, implementation, management and analysis of quantitative and qualitative research on purchasing behaviors and perceptions of regional food systems in low-income and Hispanic and African American communities
- Managing and analyzing both quantitative and qualitative public health data using STATA, Mplus and HyperResearch analytic software
- Disseminating findings at academic conferences and in academic journals

Project: *Innovative Supermarket Intervention Strategies Aimed at Increasing the Purchase of Healthy Promoted Foods*

Principal Investigator: *Pamela Surkan, PhD, ScD*

- Designed and implemented a healthy eating intervention at a supermarket in a food insecure community
- Designed and lead community outreach events to increase participation in the intervention
- Conducted regular process evaluation of over 300 promoted food items to measure implementation fidelity
- Conducted customer intercepts to evaluate reach and dose of intervention
- Managed and analyzed data using STATA
- Presented findings at academic conferences, in academic journals and to community organizations
- Produced study documents including IRB research plans, consent forms, recruitment and eligibility materials and survey instruments

Project: *The Farmers' Market Study*

Principal Investigator: *Anne Palmer, MAIA*

- Served as lead in collecting, cleaning, managing and analyzing quantitative data on social and structural drivers of purchasing behaviors among SNAP-users at Baltimore City Farmers' Markets
- Managed and analyzed data using STATA
- Disseminated findings to Maryland Farmers' Market Association and Maryland Hunger Solutions
- Drafted study documents including IRB submissions, consent forms, recruitment and eligibility materials and data collection instruments

Project: *Baltimore City Community Food Assessments*

Principal Investigator: *Anne Palmer, MAIA*

- Managed and analyzed data on community food assessments in underserved Baltimore communities
- Created reports and presented findings to community organizations
- Served as primary liaison between Principal Investigators and Institutional Review Board

Community Program Specialist, January 2008 – July 2011

Department of Environmental Health Sciences

University of Minnesota School of Public Health, Minneapolis, MN

Project: *Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial*

Principal Investigator: *Timothy Church, PhD*

- Participated in a multi-center National Cancer Institute-sponsored randomized trial of over 150,000 participants to determine the effects of screening on cancer-related mortality and secondary endpoints
- Reviewed and processed medical record releases to obtain cancer diagnoses, treatment and death documentation from health care facilities
- Coordinated priority and follow-up procedures for participant and facility contact
- Identified and obtained appropriate pathology tissue for review by NCI
- Maintained detailed collection statistics on all pathology initiatives
- Drafted and processed loan agreements with pathology laboratories
- Prepared quarterly reports for submission to the NCI

Project: *National Lung Screening Trial*

Principal Investigator: *Timothy Church, PhD*

- Assisted in a multi-center NCI-sponsored randomized trial of over 50,000 current and former smokers comparing CT scan and chest X-ray in early detection of lung cancer
- Reviewed medical records to obtain diagnoses, treatment and death documentation from health care facilities
- Managed priority and follow-up procedures for participant and facility contact
- Procured pathology tissue for NCI review
- Kept detailed collection statistics on all pathology review initiatives
- Managed loan agreements with pathology laboratories
- Drafted quarterly reports for NCI submission

Project: *Study of In-Home Screening Tests*

Principal Investigator: *Timothy Church, PhD*

- Co-coordinated a randomized pilot study on sensitivity and specificity of three types of fecal occult blood tests
- Drafted study documents including IRB submissions, consent forms, recruitment and eligibility materials and survey and data instruments
- Participated in all discussions on study protocols, randomization and recruitment strategies and data flow

Project: *Minnesota Taconite Workers Health Study*

Principal Investigator: *Jeffrey Mandel, MD, MPH*

- Prepared all research agreements for state, county and federal governments in order to access death records for mesothelioma research
- Kept detailed data on all research agreements and data flow
- Prepared status reports for coordinator and investigator review

Project: *PreSept Colon Cancer Biomarker Study*

Principal Investigator: *Timothy Church, PhD*

- Served as co-coordinator, interfaced with potential participants, answered protocol questions

- Instructed participants on colonoscopy preparations and procedures
- Monitored bi-weekly specimen shipments

Project: *William C. Bernstein M.D. Familial Cancer Registry*

Principal Investigator: *Timothy Church, PhD*

- Reviewed, edited and generated pedigree documents for registrants' family histories
- Created a file tracking system to efficiently monitor study progress and data flow

Project:: *National Children's Study*

Principal Investigator: *Timothy Church, PhD*

- Compiled a clinic database to be used as a recruiting and screening instrument
- Reviewed and modified a widely-used screening tool to better fit data entry systems and study protocols

HONORS AND AWARDS

Center for a Livable Future – Lerner Fellowship, Johns Hopkins Bloomberg School of Public Health, 2013-2017

Journal of Nutrition Education and Behavior – 2017 Best Paper Award. *Eat Right–Live Well! Supermarket Intervention Impact on Sales of Healthy Foods in a Low-Income Neighborhood.*

Health, Behavior and Society Student Organization Teaching Assistant Award

TEACHING EXPERIENCE

Teaching Assistant

Johns Hopkins Bloomberg School of Public Health, Department of Health, Behavior and Society

Course: *Implementation and Sustainability Community-Based Programs* (2014, 2015, 2016)

Johns Hopkins Bloomberg School of Public Health, Department of Environmental Health

Course: *Food Production, Public Health and the Environment* (2014)

PEER REVIEWED PUBLICATIONS

Fry, J. P., Love, D. C., Shukla, A., & **Lee, R. M.** (2014). Offshore Finfish Aquaculture in the United States: An Examination of Federal Laws That Could be Used to Address Environmental and Occupational Public Health Risks. *International Journal of Environmental Research and Public Health*, 11(11), 11964–11985.

Lee, R. M., Rothstein, J. D., Gergen, J., Zachary, D. A., Smith, J. C., Palmer, A. M., . . . Surkan, P. J. (2015). Process Evaluation of a Comprehensive Supermarket Intervention in a Low-Income Baltimore Community. *Health Promotion Practice*, 16(6), 849-858.

Surkan, P. J., Tabrizi, M. J., **Lee, R. M.**, Palmer, A. M., & Frick, K. D. (2016). Eat Right–Live Well! Supermarket Intervention Impact on Sales of Healthy Foods in a Low-Income Neighborhood. *Journal of Nutrition Education and Behavior*.

CONFERENCE PRESENTATIONS

Lee, R.M., Rothstein, J., Gergen, J., Zachary, D.A., Palmer, A.M., Gittelsohn, J. & Surkan, P.J. Process Evaluation of a Comprehensive Supermarket Intervention in a Low-Income Baltimore Community. Abstract presented at the annual conference of the Society for Nutrition Education and Behavior. June 28-July 1, 2014.

Palmer, A.M., **Lee, R.M.** & McNab, P. Preliminary findings on perceptions of regionality research from *Enhancing Food Security in the Northeast* presented at the National Value-Added Agriculture Conference. May 13-May 15, 2014.

Bonanno, A., Chenarides, L. and **Lee, R.M.** “Assessing the Healthfulness of Food Purchases among Underserved Shoppers in the Northeast.” Selected Paper for the NAREA and CAES Joint Annual Meeting, Newport, RI. June 28–30, 2015.

DEMONSTRATED SKILLS

Proficiency in STATA, Mplus and HyperResearch analysis software • proficient in Microsoft Office suite • skilled in design and implementation of public health research • experienced in the management and analysis of large quantitative and qualitative data sets • research in underserved populations • collaboration in multi-center research • experienced in production and maintenance of IRB documentation for human subjects research